ACADEMIC CURRICULA

POSTGRADUATE DEGREE PROGRAMME

MASTER OF SCIENCE
IN
APPLIED DATA SCIENCE

Two Years

Learning Outcomes Based Curriculum Framework (LOCF)

Choice Based Flexible Credit System

Academic Year

2021 - 2020

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University u/s 3 of UGC Act, 1956)

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

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DEPARTMENT OF COMPUTER APPLICATIONS

1. Department Vision Statement	
Stmt - 1	*Creating the most conducive environment for imparting quality education in Computer Science specialized in Data Science*
Stmt - 2	*Contributing effectively to produce globally competent quality professionals in the field of IT and Data Science*
Stmt - 3	*Contributing towards preparing young minds to serve community*

2. Department Mission Statement	
Stmt - 1	*Impart student's essential knowledge and skills required for a successful career in Data Science*
Stmt - 2	*Instill confidence in the students to take up new challenges by grooming them appropriately*
Stmt - 3	*Inculcate in the students a sense of commitment to professional ethics, moral values with emphasis on team work and leadership qualities*
Stmt - 4	*Instill the students with a clear awareness of environmental issues and their relevance to their profession*
Stmt - 5	*Impress upon the students the impact of their work on the nation's economic and social progress*

3. Program Education Objectives (PEO)	
PEO - 1	*Offer the students those skill sets and domain knowledge based on needs of IT specialized in Data Science and dynamic business environment*
PEO - 2	*Provide the students with the capabilities in the areas of analysis, design, development and testing*
PEO - 3	*Kindle the minds of students to take up research and development in Data Science with missionary zeal*
PEO - 4	*Train the students to become effective communicators in professional as well as general aspects of life*
PEO - 5	*Prepare the students into balanced individuals who are keen to leave a mark by excelling in their profession*

4. Consistency of PEO's with Mission of the Department

	Mission Stmt. - 1	Mission Stmt. - 2	Mission Stmt. - 3	Mission Stmt. - 4	Mission Stmt. - 5
PEO – 1	H	H	M	H	M
PEO – 2	H	M	H	H	H
PEO – 3	M	H	M	H	H
PEO – 4	H	H	H	L	M
PEO - 5	L	H	M	H	H

H – High Correlation, M – Medium Correlation, L – Low Correlation

5. Consistency of PEO's with Program Learning Outcomes (PLO)

	Program Learning Outcomes (PLO)														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
PEO – 1	H	H	H	H	H	L	M	L	M	M	H	H	M	H	H
PEO – 2	H	H	H	H	H	L	M	L	M	H	M	M	H	H	M
PEO – 3	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PEO – 4	H	M	M	H	H	H	M	H	H	H	H	L	M	M	H
PEO - 5	M	M	H	H	M	H	M	H	H	H	M	M	H	M	M

H – High Correlation, M – Medium Correlation, L – Low Correlation

6. Programme Structure

1. Professional Core Courses (C)
(6 Courses)

Course Code	Course Title	Hours / Week			
		L	T	P	C
PAD21101T	Statistical Foundations	4	0	0	4
PAD21102J	Data Analysis Fundamentals	4	0	4	6
PAD21201J	Data Visualization and Concepts	3	0	4	5
PAD21202J	Building Machine Learning Pipelines	3	0	4	5
PAD21301J	Deep Learning for Data Science	4	0	4	6
PAD21302T	Enterprise Machine Learning	4	0	0	4
Total Learning Credits					**30**

2. Discipline Elective Courses (D)
(3 Courses)

Course Code	Course Title	Hours / Week			
		L	T	P	C
PAD21D01T	Data Engineering and Governance	4	0	0	4
PAD21D02T	Data Architecture and Big Data				
PAD21D03T	Data Mining and Warehousing				
PAD21D04T	Machine Learning Model Management	4	0	0	4
PAD21D05T	Natural Language Processing				
PAD21D06T	Reinforcement Learning for AI				
PAD21D07J	Cloud Computing	4	0	4	6
PAD21D08J	Exploratory Data Analysis				
PAD21D09J	Social Media and Text Analytics				
Total Learning Credits					**14**

3. Generic Elective Courses (G)
(Any 1 Course)

Course Code	Course Title	Hours / Week			
		L	T	P	C
PAD21G01T	Mathematics for Data Science	4	0	0	4
PAD21G02T	Digital Marketing Analytics				
PAD21G03T	Time Series Analysis				
Total Learning Credits					**4**

4. Skill Enhancement Courses (S)
(2 Courses)

Course Code	Course Title	Hours / Week			
		L	T	P	C
PAD21S01J	Machine Learning for Data Science	4	0	4	6
PAD21S02J	Artificial Intelligence	3	0	4	5
Total Learning Credits					**11**

5. Project Work, Internship In Industry / Higher Technical Institutions (P)
(3 Courses)

Course Code	Course Title	Hours / Week			
		L	T	P	C
PAD21P01L	Internship	-	-	-	2
PAD21P02L	Mini Project Work	-	-	8	4
PAD21P03L	Project Work	0	0	24	12
Total Learning Credits					**18**

6. Ability Enhancement Courses (AE)
(3 Courses)

Course Code	Course Title	Hours / Week			
		L	T	P	C
PCD21AE1T	Professional Skills and Problem Solving	1	0	0	**1**
PCD21AE2T	General Aptitude for Competitive Examinations	1	0	0	**1**
PCD21AE3T	Employability Skills	1	0	0	**1**
Total Learning Credits					**3**

As SRMIST strongly encourages the use of SWAYAM (Study Web of Active Learning by Learning by Young and Aspiring Minds) platform, the students are encouraged to choose at least one core/ elective course from SWAYAM on the recommendation of the faculty advisor and the credits will be transferred

Course Structure								
Semester	**Professional Core Courses (PCC)**	**Discipline Electives Courses (DEC)**	**Generic Electives Courses (GEC)**	**Skill Enhancement Courses (SEC)**	**Ability Enhancement Courses (AEC)**	**Project Work, Internship (P)**	**Total Credits**	**Total Hours**
Sem I	PCC-1(4) PCC-2 (6)	DEC-1 (4)		SEC 1 (6)	AEC 1(1)		**21**	**28**
Sem II	PCC-3(5) PCC-4 (5)	DEC-2 (4)	GEC (4)	SEC 2 (5)	AEC 2 (1)		**24**	**30**
Sem III	PCC-5 (6) PCC-6 (4)	DEC-3 (6)			AEC 3 (1)	P (2) P(4)	**23**	**29**
Sem IV						P (12)	**12**	**24**
Total Credits	**30**	**14**	**4**	**11**	**3**	**18**	**80**	

7. Implementation Plan

Semester - I

Course Code	Course Title	Hours/ Week			C
		L	T	P	
PAD21101T	Statistical Foundations	4	0	0	4
PAD21102J	Data Analysis Fundamentals	4	0	4	6
PAD21D01T	Data Engineering and Governance	4	0	0	4
PAD21D02T	Data Architecture and Big Data				
PAD21D03T	Data Mining and Warehousing				
PAD21S01J	Machine Learning for Data Science	4	0	4	6
PCD21AE1T	Professional Skills and Problem Solving	1	0	0	**1**
Total Learning Credits					21

Semester - II

Course Code	Course Title	Hours/ Week			C
		L	T	P	
PAD21201J	Data Visualization and Concepts	3	0	4	5
PAD21202J	Building Machine Learning Pipelines	3	0	4	5
PAD21D04T	Machine Learning Model Management	4	0	0	4
PAD21D05T	Natural Language Processing				
PAD21D06T	Reinforcement Learning for AI				
PAD21G01T	Mathematics for Data Science	4	0	0	4
PAD21G02T	Digital Marketing Analytics				
PAD21G03T	Time Series Analysis				
PAD21S02J	Artificial Intelligence	3	0	4	5
PCD21AE2T	General Aptitude for Competitive Examinations	1	0	0	**1**
Total Learning Credits					24

Semester – III

Course Code	Course Title	Hours/ Week			C
		L	T	P	
PAD21301J	Deep Learning for Data Science	4	0	4	6
PAD21302T	Enterprise Machine Learning	4	0	0	4
PAD21D07J	Cloud Computing	4	0	4	6
PAD21D08J	Exploratory Data Analysis				
PAD21D09J	Social Media and Text Analytics				
PAD21P01L	Internship	0	0	0	2
PAD21P02L	Mini Project Work	0	0	8	4
PCD21AE3T	Employability Skills	1	0	0	**1**
Total Learning Credits					23

Semester - IV

Course Code	Course Title	Hours/ Week			C
		L	T	P	
PAD21P03L	Project Work	0	0	24	12
Total Learning Credits					12

Total Learning Credits :80

8. Program Articulation Matrix

Course Code	Course Name	Programme Learning Outcomes														
		Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
PAD21101T	*Statistical Foundations*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21102J	*Data Analysis Fundamentals*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21201J	*Data Visualization and Concepts*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21202J	*Building Machine Learning Pipelines*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21301J	*Deep Learning for Data Science*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21302T	*Enterprise Machine Learning*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21D01T	*Data Engineering and Governance*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D02T	*Data Architecture and Big Data*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D03T	*Data Mining and Warehousing*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D04T	*Machine Learning Model Management*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D05T	*Natural Language Processing*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D06T	*Reinforcement Learning for AI*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D07J	*Cloud Computing*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D08J	*Exploratory Data Analysis*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21D09J	*Social Media and Text Analytics*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PAD21G01T	*Mathematics for Data Science*	H	H	H	H	H	M	M	L	M	H	M	M	H	H	M
PAD21G02T	*Digital Marketing Analytics*	H	H	H	H	H	M	M	L	M	H	M	M	H	H	M
PAD21G03T	*Time Series Analysis*	H	H	H	H	H	M	M	L	M	H	M	M	H	H	M
PAD21S01T	*Machine Learning for Data Science*	H	H	H	H	H	M	M	L	M	M	H	H	M	H	H
PAD21S02J	*Artificial Intelligence*	H	H	H	H	H	M	M	L	M	H	M	M	H	H	M
PAD21P01L	*Internship*	M	M	H	H	M	H	M	H	H	H	M	M	H	M	M
PAD21P02L	*Mini Project Work*	H	H	H	H	H	M	M	L	M	M	M	H	M	H	H
PAD21P03L	*Project Work*	H	H	H	H	H	M	M	L	M	M	M	H	M	H	H
PCD21AE1T	*Professional Skills and Problem Solving*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PCD21AE2T	*General Aptitude for Competitive Examinations*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
PCD21AE3T	*Employability Skills*	H	H	H	H	H	M	H	M	M	M	H	H	H	M	M
	Program Average	H	H	H	H	H	M	M	M	M	M	M	H	H	H	H

H – High Correlation, M – Medium Correlation, L – Low Correlation

SEMESTER – I

Course Code	PAD21101T	Course Name	STATISTICAL FOUNDATIONS	Course Category	C	Professional Core Course	L	T	P	C
							4	0	0	4

Pre-requisite Courses	*Nil*	Co-requisite Courses	*Nil*	Progressive Courses	*Nil*
Course Offering Department	*Mathematics and Statistics*	Data Book / Codes/Standards	*Statistical Table and Graph sheet*		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*To provide the extensive knowledge of basic statistical concepts*
CLR-2 :	*To understand the Concepts of discrete distributions-Binomial distribution*
CLR-3 :	*To learn the concepts of continuous distribution – Normal distribution and their properties*
CLR-4 :	*To acquire the knowledge of sampling , statistical hypothesis testing*
CLR-5 :	*To gain the knowledge of design of experiments*
CLR-6 :	*To understand and interpret data using Testing of Hypothesis based on non-parametric methods*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Fundamental Knowledge	Application of Concepts	Link with Related Disciplines	Procedural Knowledge	Skills in Specialization	Ability to Utilize Knowledge	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	*To acquire the knowledge of data organist ion, descriptive measures and probability*	*3*	*85*	*80*	*L*	*H*	*H*	*M*	*-*	*-*	*-*	*-*	*-*	*H*	*H*	*-*	*-*	*M*	*H*
CLO-2 :	*To collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data.*	*3*	*80*	*75*	*M*	*H*	*H*	*H*	*H*	*H*	*-*	*M*	*-*	*H*	*H*	*-*	*-*	*M*	*H*
CLO-3 :	*To identify distribution form relating to the variable/variables.*	*3*	*85*	*80*	*M*	*H*	*H*	*M*	*H*	*H*	*-*	*M*	*-*	*H*	*H*	*-*	*-*	*M*	*H*
CLO-4 :	*To acquire the skill of analysing the relationship between the independent and dependent variables*	*3*	*85*	*80*	*M*	*H*	*H*	*H*	*-*	*-*	*-*	*-*	*-*	*H*	*M*	*-*	*-*	*M*	*H*
CLO-5 :	*To apply different methods of sampling and the testing of hypothesis for Big data*	*3*	*85*	*80*	*H*	*H*	*M*	*M*	*M*	*M*	*M*	*M*	*-*	*H*	*H*	*-*	*M*	*M*	*H*
CLO-6 :	*To apply hypothesis testing via non-parametric tesys*	*3*	*85*	*80*	*M*	*H*	*H*	*M*	*-*	*-*	*-*	*-*	*-*	*H*	*H*	*-*	*-*	*M*	*H*

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Definition of Statistics, Types of variables*	*Definition -Discrete Random Variable, Probability Mass Function, and Cumulative distribution function*	*Definition – continuous random variables*	*Definition of sampling, types of sampling techniques*	*Definition – non-parametric test, application*

	SLO-2	*Classification and tabulation of data*	*Expectation of discrete distribution*	*Expectation of continuous distribution*	*Definition of hypothesis testing, level of significance, type – I error, type-II error*	*Sign test - procedure*
S-2	**SLO-1**	*Descriptive statistics- measures of central tendency*	*Problems on discrete distribution*	*Problems on continuous distribution*	*Concepts of One tailed test and two tailed test*	*Problems on sign test*
	SLO-2	*Descriptive statistics- measures of central tendency*	*Problems on discrete distribution*	*Problems on continuous distribution*	*Determination of sample size*	*Problems on sign test*
S-3	**SLO-1**	*Descriptive statistics- measures of central tendency*	*Problems on discrete distribution*	*Definition of Normal distribution*	*Determination of sample size*	Wald-Wolfowitz Run Test - procedure
	SLO-2	*Descriptive statistics- measures of central tendency*	*Problems on discrete distribution*	*Importance of Normal distribution*	*Large sample test – one sample test statistic*	*Run test- One sample test- problem*
S 4	**SLO-1**	*Measures of dispersion-problems*	*Problems on discrete distribution*	*Uses of Normal distribution*	*Problems on single sample mean*	*Run test – two sample- problems*
	SLO-2	*Measures of dispersion-problems*	*Definition of Binomial distribution and its applications*	*Properties of normal distribution*	*Equality of two sample mean – test statistics*	*Run test – two sample- problems*
S-5	**SLO-1**	*Measures of dispersion-problems*	*Fitting of Binomial distribution*	*Definition of Standard Normal distribution*	*Equality of two sample mean – test statistics*	*Median test – procedure*
	SLO-2	*Probability – types of events*	*Problems on Binomial distribution*	*Area properties of standard normal distribution*	*Small sample test – single mean*	*Problem – median test*
S - 6	**SLO-1**	*Conditional probability –Bayes theorem*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Equality of two mean - problem*	*Kolmogorov Smirnov test – procedure*
	SLO-2	*Problems on probability*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Equality of two mean - problem*	Problems on KS test
S- 7	**SLO-1**	*Probability distribution- discrete and continuous distribution*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Equality of two mean - problem*	Problems on KS test
	SLO-2	*Definition – correlation analysis, properties, Karl Pearson's coefficient of correlation*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Paired t-test – test statistic*	Problems on KS test
S - 8	**SLO-1**	*Problems on correlation*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Problems on dependent samples*	Problems on KS test
	SLO-2	*Problems on correlation*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Chi-square test – independent of attributes and goodness of fit*	Problems on KS test
S - 9	**SLO-1**	*Problems on correlation*	*Problems on Binomial distribution*	*Problems on normal distribution*	*2 X 2 contingency table*	Problems on KS test
	SLO-2	*Definition of Regression Analysis, properties*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Problems on independence of attributes*	Wilcoxon test - procedure
S - 10	**SLO-1**	*Problems on Regression lines*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Problems on independence of attributes*	Problems on Wilcoxon test

	SLO-2	*Problems on regression lines*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Problems on goodness of fit*	Problems on KS test
S-11	**SLO-1**	*Problems on regression lines*	*Problems on Binomial distribution*	*Problems on normal distribution*	*Design of experiment – ANOVA*	Mann Whitney tesy - procedure
	SLO-2	*Problems on regression lines*	*Mean and variance of binomial distribution*	*Problems on normal distribution*	*One-way classification – problem*	Problems on MW test
S-12	**SLO-1**	*Properties of regression coefficients*	*Mean and variance of binomial distribution*	*Problems on normal distribution*	*Two-way ANOVA - problem*	Problems on MW test
	SLO-2	*Properties of regression coefficients*	*Mean and variance of binomial distribution*	*Problems on normal distribution*	*Two-way ANOVA - problem*	Problems on MW test

Learning Resources	***Theory:*** *1. Pratap Dangeti, Statistics for Machine Learning, Practical Statistics for Data Scientists, 2nd Edition,* 2020 *Andrew Bruce and Peter Gedeck,* *2.* Davis Freedman, Robert Pisani and Roger Purves, An Easy to Understand Guide to Statistics and Analytics, Third Edition, By David M. Levine and David F. Stephan, December 2014 *3.* Robert A. Donnelly and Fatma Abdel-Raou, Statistics, 3E, July

	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA_1 (10%)		**CLA_2 (10%)**		**CLA_3 (20%)**		**CLA_4 (10%)**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	30%	-	30%	-	30%	-	30%	-	30%	-
	Analyze										
Level 3	Evaluate	30%	-	30%	-	30%	-	30%	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers	
Experts from Academic	**Internal Experts**
Dr.Muthu, Professor, Loyola College, Chennai	M.Kalaivani, Assistant Professor, Dept. of Mathematics & Statistics, SRMIST, KTR
Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21102J	Course Name	DATA ANALYSIS FUNDAMENTALS	Course Category	C	Professional Core Course	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning
CLR-1 :	Gather extensive knowledge in Data analysis and fundamental techniques	
CLR-2 :	Improve and understand effective python programming language	
CLR-3 :	Strengthen the knowledge on numpy and Pandas tools.	
CLR-4 :	Improve the problem-solving quality using data structure techniques	
CLR-5 :	Gather extensive knowledge in Data Structures	
CLR-6 :	Strengthen the knowledge in algorithms.	

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of	Expected	Expected	Fundamental	Application of	Link with	Procedural	Skills in	Ability to Utilize	Skills in	Analyze,	Investigative	Problem	Communication	Analytical Skills	ICT Skills	Professional	Life Long
CLO-1 :	Apply basic mathematical concepts in Data Analysis	2	80	70	H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
CLO-2 :	Work with powerful framework	3	85	75	H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
CLO-3 :	Deal with Numpy and Pandas tools	3	75	70	H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
CLO-4 :	Analyze various types data structure techniques	3	85	80	H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
CLO-5 :	Apply various network models in deep learning	3	85	75	H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
CLO-6 :	Apply data sampling techniques	3	80	70	H	H	H	H	H	M	L	M	H	M	-	H	H	H	M

Duration (hour)		24	24	24	24	24
S-1	SLO-1	*Introduction to Data Science and Python Programming foundations*	*Advanced Python*	Pandas for Data Analysis	NumPy Basics and Manipulation	Statistical foundation for Data Science
	SLO-2	What is data science – Use cases of data science – Tools and programming languages	Generators – Generators expressions – Brief tour of standard library	Built-in styles – sharing styles – other options – fun stuff – export to excel	NumPy basic operations – Universal functions	**Data sampling terms – sampling bias – simple random sampling –**
S-2	SLO-1	Installation of Python –Using the Python interpreter – Invoking the interpreter – Argument passing – Interactive mode	Operations system interface	extensibility – options and settings – getting and setting options – environment	**indexing and slicing – iterating over arrays**	systematic random – sampling – stratified sampling

	SLO-2	The interpreter and its environment – Source coding	File wildcards– Command line arguments –	Frequently used options – available option	Array reshape – Image as bumpy arrays	**Non-probability sampling – Gaussian distribution – Inferential statistics and Hypothesis testing**
S-3	SLO-1	Informal introduction to Python – Numbers – Strings – Lists – first steps towards the programming	Error output redirection and program termination	Number formatting – Unicode formatting –	**Views and bumpy arrays**	**Hypothesis testing applied – T-Test – kurtosis and skewness**
	SLO-2	More control flow tools – if statements – Range function – Break and Continue statements – and else clause on loops – Pass statements	String pattern matching – Mathematics	Table schema display – enhancing performance	Creating array deep copies	**Correlation and autocorrelation**
S-4	SLO-1	Defining the functions – more on defining functions	Internet access – Date and times – Data compression	Python (writing c extensions for pandas) –using Numba	Understanding and applying index masks – structured arrays	**Introduction to linear – Regression – model fitting**
	SLO-2	Default arguments values – Keyword arguments – Special parameters Positional-or-keyword arguments –Positional(only parameters) – Keywords(only argument)	Performance measurement – Quality control	Expression evaluation via eval() – scaling to large datasets – load less data	**Understanding array broadcasting**	**Descriptive and Inferential Statistics – population vs sample –**
S 5 – S 8	SLO-1	**Implement a Python program to calculate GCD of two numbers** **Implement a Python program to calculate the square root of a number by Newton's method**	**Demonstrate use of and query()**	**Solve algorithmic problems by program using different problem-solving strategies**	**Perform Linux administration task using Python**	**Demonstrate handling of missing data**
S9	SLO-1	Function examples – Arbitrary arguments list –Unpacking argument lists	Batteries included – brief tour of the Standard Library	use efficient data types – use chunking – use other libraries	Iterating on data frame contents	**Probability Vs Non-Probability sampling Mean/Median/Model**

	SLO-2	Lambda expressions – Documentation strings – Function annotations	Output formatting – Templating	migrating	**Exporting a data frame – sorting**	**QR – variance – The One-Sample T-Test – Independent and paired T-Test**
S10	SLO-1	Data structures – more on Lists – using Lists as Stacks – using List as Queues – List comprehensions – the del statement	Working with binary data record layouts	Intereraction with script sparse	**Handling missing data**	**testing – Hypotheses With T-Tests – loading and analysing A Skewed dataset**
	SLO-2	Tuples and Sequences – Sets – Dictionaries – Looping techniques –	Muti-threading – Logging	Data frame memory usage –	Grouping with index – merging with index	**measuring skewness and kurtosis – ANOVA test – interpretation of ANOVA**
S11	SLO-1	more on conditions – Comparing sequences and other types	weak references – Tools for working with lists –	Using if/truth statements with Pandas – nan – differences with NumPy	**Data-type descriptions – basic indexing (slicing)**	two way ANOVA discrete vs continuous distribution – pdf and cdf
	SLO-2	Modules – executing modules as scripts – the module search path – Complied python files	Decimal floating-point arithmetic –	Thread-salty – byte ordering issues – selection – multi-indexing	Memory layout of ndarray	Binomial distribution – interval estimation
S12	SLO-1	Standard modules – the dir() function packages importing * from a package – Intra- package references – Packages in multiple directories	Virtual environments and packages –	Missing data – grouping – timeseries	**Universal functions for arrays**	**Point and interval estimation Bayesian probability and Statistical Inference**
	SLO-1	Input and output – fancier output formatting	Introduction – creating virtual environments –	Merge – plotting – data in/out – computation –	Ndarray attributes – ndarray metds	Bayes theorem in machine learning – frequentist and subjective Probability
S 13 – S 16	SLO-1	**Implement a Python program to calculate the exponentiation of a number** **Implement a Python program to calculate the maximum from a list of numbers**	**Implement function overloading with different function signatures.**	**Search content using regular expression library in Python**	**Demonstrate aggregation**	**Demonstrate hierarchical indexing**
S17	SLO-1	Input and output – fancier output formatting	Managing packages with pip	time deltas – aliasing axis names – indexing	**Array shape manipulation**	Probability distribution – ingredients of – Bayesian statistics

	SLO-2	Methods of file objects saving structured data with json –	interactive input editing and history editing –	iteration – binary operator functions – function application	**Array indexing**	**Bayesian methods – Bayesian concepts in ml modelling – prior knowledge distribution**
S18	SLO-1	errors and expectations – Syntax errors – Exceptions – handling Exceptions – Raising exceptions – User defined exceptions	alternatives to the interactive Interpreter –	groupby & window – computations/ descriptive stats	Operations on two or more arrays	Bayesian analysis approach –
	SLO-2	Defining clean-up actions – predefined clean up actions classes	Floating point arithmetic: issues and limitations –	reindexing/ selection/label manipulation – Missing data handling	Shape functions – set operations	Bayesian learning – Bayesian – model types – probabilistic programming
S19	SLO-1	names and objects – Python scopes and namespaces	Representation error	Reshaping – voting – combining/ joining/merging – time series-related	Array construction using index tricks	Modelling with PyMC – Bayesian data – analysis process
	SLO-2	scopes and namespace example – a first look at classes – Class definition syntax	appendix – interactive mode -	Metadata – plotting- sparse accessor	Two dimensional functions –	Bayesian data analysis with PyMC – Bayesian computation methods
S20	SLO-1	Class objects – Instance objects – Method objects – class instance variables	error handling	serialization/io/ conversion – pandas array – period – panel	Method of array scalars	Markov chain simulation
	SLO-2	Random remarks – Inheritance – Multiple Inheritance – private variables – Odds and ends Iterators	executable python scripts	Index – window – groupby – style – plotting	**Special attribute and methods recognized by NumPy**	**Implementing** Markov chain simulation – finding posterior modes
S 21 - S 24	SLO-1	**Implement a Python program to calculate the most frequent words in a text read from a file**	**Implement concept of class, instances and inheritance**	**implement matrix multiplication using multi-threading in Python**	**Demonstrate indexing and sorting**	**Demonstrate usage of pivot table**

Learning Resources	1. Python Crash Course, 2nd Edition, By Eric Matthes, May 2019 2. NumPy Essentials, By Leo Chin and Tanmay Dutta, April 2016 3. Hands-On Data Analysis, By Stefanie Molin, July 2019 4. The Python Workbook by Ben Stephenson, Springer, 2014

	5. Hands-OnData Analysis, By Stefanie Molin, July 2

Learning Assessment											
Level	**Bloom's Level of Thinking**	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (20%)**		**CLA – 4 (10%)#**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	20%	20%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	10%	10%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Mr.J.Venkata Subramanian, Assistant Professor*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D01T	Course Name	DATA ENGINEERING AND GOVERNANCE	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning		
		1	2	3
CLR-1 :	*To learn the concepts of Big data*	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	*To impart in-depth knowledge of data lakes*			
CLR-3 :	*Understand the principles of Data warehouse*			
CLR-4 :	*Basic knowledge of lake on AWS*			
CLR-5 :	*Basic knowledge of distributed computing using Spark*			
CLR-6 :	*Design principles of* Resilient distributed datasets			

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*			
CLO-1 :	*Have a thorough Understanding of Big data*	*3*	*80*	*70*
CLO-2 :	*Understand the concepts of Data warehouse*	*3*	*85*	*75*
CLO-3 :	*Real time applications of* Data lake design principles	*3*	*75*	*70*
CLO-4 :	*Deployment knowledge of AWS*	*3*	*85*	*80*
CLO-5 :	*Design and implementation knowledge of* Spark data frames	*3*	*85*	*75*
CLO-6 :	*Real time application of* accumulator param	*3*	*80*	*70*

Program Learning Outcomes (PLO)															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Fundamental Knowledge	Application of Concepts	Link with Related	Procedural Knowledge	Skills in Specialization	Ability to Utilize Knowledge	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning	
H	*H*	*M*	-	-	-	-	-	*H*	*H*	-	-	*M*	*H*	*H*	
H	*H*	*H*	*H*	*H*	-	*M*	-	*H*	*H*	-	-	*M*	*H*	*H*	
H	*H*	*M*	*H*	*H*	-	*M*	-	*H*	*H*	-	-	*M*	*H*	*H*	
H	*H*	*H*	-	-	-	-	-	*H*	*M*	-	-	*M*	*H*	*H*	
H	*M*	*M*	*M*	*M*	*M*	*M*	-	*H*	*H*	-	*M*	*M*	*H*	*H*	
H	*H*	*M*	-	-	-	-	-	*H*	*H*	-	-	*M*	*H*	*H*	

Duration (hour)		12	12	12	12	12
S-1	SLO-1	DataArchitecture: Data and Data lifecycle databases and it's types	BigData :Introduction to big data	DataLakeArchitecture: Data silos	Data LakeonAWS: Data lakes and Data warehouses	Distributed Computing usingSpark: PySpark and SQL basics introduction to spark and Hadoop
	SLO-2	SQL vs NoSQL , creating ERD (entity relationship diagram) ,implementing SQL with AWS	building systems to scale with data	Data lakes	Data lake selection criteria	Resilient distributed datasets(RDD) , Spark data frames

S-2	SLO-1	implementing NoSQL with AWS , create , NoSQL DB with python	building systems to scale with data	Data lakes	Data lake and data	Spark architecture
	SLO-2	create SQL DB with python , big data		characteristics of Data lakes	Democratization	working with RDD
S-3	SLO-1	reading data from csv	a quick overview of Hadoop	Data lake architecture	Data lake design principles	creating data frames for RDD – SQL context
	SLO-2	overview of the four vs the importance of volume			AWS Data lake architecture	map() function of RDD
S-4	SLO-1	the importance of variety , the importance of velocity	Map-Reduce overview	Data warehouse	Implement AWS data store	access content of data frame
	SLO-2	the importance of veracity		Data Lakes	Data lake for on-premise and multi-cloud	data frame in spark and Pandas , performance improvements in Spark
S-5	SLO-1	the relationship between the four VS	Map-Reduce overview	Data streams	data processing frameworks for data lake	broadcast variables and accumulators – loading data into a data frame
	SLO-2	Variety and Data structure			real-time big data architectures	Sampling the contents of a data frame
S-6	SLO-1	Validity and Volatility	map phase	Data streams	Data lake reference architecture	grouping and aggregations – visualizing data in a data frame
	SLO-2	finding balance in the four VS use cases			data ingestion and file formats	trimming and cleaning data
S-7	SLO-1	extracting value from the four VS Data driven organizations	map phase of Map-Reduce	migrate data to AWS	ingestion using Sqoop	user-defined functions and Data frames – combining filters –
	SLO-2				Data processing strategies	aggregations – and sorting – using broadcastvariables
S-8	SLO-1	decision making	Shuffle Phase	migrate data to AWS	deriving value from data lakes	using accumulators – exporting
	SLO-2	distributed systems			data life cycle – and glacier	data frame Contents – Custom accumulators
S-9	SLO-1	batch vs in- memory processing	Shuffle Phase	data lakes on AWS	create role for AWS glue service	Join operations – the Spark catalyst optimizer
	SLO-2	tools for data management			upload data to explore the glue web console	Introduction To Spark SQL – Preparing Data For Analysis – Running SQL Queries
S-10	SLO-1	understanding ETL	reducephase	data lakes on AWS	manually create glue table	Inferred And Explicit Schemas – Windowing In Spark
	SLO-2	ETL with Talend open studio			query data lake using amazon Athena	applying – Window Functions – PySpark Basics – sparkconf

S-11	SLO-1	ETL pipeline in Python , AI and machine learning	reducephase	Working with data lakes	configure and run glue crawlers	Spark context – Spark files – RDD – Storage level – Broadcast
	SLO-2	data modelling			access data in crawled tables	accumulator – accumulatorparam – marshalserializer – Pickle serializer – Status tracker
S-12	SLO-1	data partitioning/engineering/ reporting	Difference between Shuffle and Reduce Phase	Data Lakes on AWS	Crawl CSV files, merge data	sparkjobinfo – sparkstageinfo – profiler – basic profiler
	SLO-2				Same schema file manipulation	evaluatorpyspark.ml.tuning Module – PySpark SQL functions – PySpark SQL data Types

Learning Resources	**Text Book:** 1.Data Architecture: A Primer for the Data Scientist, 2nd Edition, By W.H.Inmon, Daniel Linstedt and Mary Levins, April 2019 2.Data Architecture, By Charles Tupper, May 2011	**Reference Book:** 1.Concise Guide to Databases by Peter Lake and Paul Crowther, Springer, 2013 2.The Enterprise Big, Data Lake, By Alex Gorelik, March 2019 3.Apache Spark with Python - Big Data with PySpark and Spark, By Pedro Magalhães Bernardo, Tao W and James Lee, May 2018

Learning Assessment

Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	30%	-	30%	-	30%	-	30%	-	30%	-
	Analyze										
Level 3	Evaluate	30%	-	30%	-	30%	-	30%	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Mrs. Vasavi J , CSH, SRM IST*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D02T	Course Name	DATA ARCHITECTURE AND BIG DATA	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLR-1 :	To learn how to Data architects help companies manage, store and secure their data.																		
CLR-2 :	To learn about SQL and NoSQL databases																		
CLR-3 :	To get a clear understanding about Hadoop																		
CLR-4 :	To get in-depth knowledge of the Big Data framework using Hadoop																		
CLR-5 :	To analyze large data sets to find trends, correlations or other insights not visible with smaller data sets or traditional processing methods.																		
CLR-6 :	To observe various customer related patterns and trends.																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	To gather extensive knowledge in Big Data and its architecture	2	85	80	L	H	H	H	H	M	-	H	M	H	-	H	-	-	-
CLO-2 :	To improve and understand ETL process and relevant ETL tools	3	85	80	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-3 :	To differentiate between a batch layer for large volumes of data and a speed layer for real time processing of data streams	3	85	80	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-4 :	To understand Distributed systems	3	85	80	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-5 :	To understand Data modelling techniques	3	85	80	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-6 :	To incorporate data from all sources is key to optimizing the insights gained with Big Data.	3	85	80	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to Data and Data lifecycle principles	Introduction to Big data and Hadoop	Four V's in Big Data	Distributed computing and ETL	Data lake and data warehouse
S-2	SLO-1	Data and data lifecycle	Introduction to Bigdata	Big Data - reading data from CSV	Data Driven Organizations	Data lakes
S-3	SLO-1	Databases	Characteristics of Big Data	Overview of the Four Vs	Decision Making	Characteristics of data lakes
S-4	SLO-1	Database types	Getting started with Hadoop	The Importance of Volume	Distributed systems	Data lake Architecture
S-5	SLO-1	SQL	Building systems to scale with data	The Importance of Variety - The Importance of Velocity	Batch vs in-memory processing	Data warehouse

S-6	SLO-1	NoSQL	A quick overview of Hadoop	The Relationship	Tools for data management	Characteristics of Data Warehouse
S-7	SLO-1	Creating ERD (Entity relationship diagram)	MapReduce overview	Between the Four Vs	Understanding ETL	Data warehouse Architecture
S-8	SLO-1	Implementing SQL with AWS	Map	Variety and Data Structure	ETL with Talend open studio	Data lakes Vs Data Streams
S-9	SLO-1	Implementing NoSQL with AWS	Phases of MapReduce	Validity and Volatility	ETL pipeline in python	Data streams
S-10	SLO-1	Create NoSQL	Shuffle phase	Finding Balance in the – Four Vs	AI and machine learning	Migrate data to AWS
S-11	SLO-1	NoSQL DB with python	Reduce phase	**Use Cases**	Data modelling	Data lakes on AWS
S-12	SLO-1	Create SQL DB with python	Data Silos	Extracting Value from the Four V's	Data partitioning/engineering/ reporting	Working with data lakes on AWS

Learning Resources	1.Big Data Fundamentals: Concepts, Drivers & Techniques, By Wajid Khattak, Paul Buhler and Thomas Erl, January 2016 2.The Enterprise Big Data Lake, Alex Gorelik, March 2019	1.Practical Enterprise Data Lake Insights: Handle Data-Driven Challenges in an Enterprise Big Data Lake, Saurabh Gupta and Venkata Giri, June 2018

Learning Assessment

Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40%	-	40%	-	40%	-	40%	-	40%	-
Level 2	Apply Analyze	40%	-	40%	-	40%	-	40%	-	40%	-
Level 3	Evaluate Create	20%	-	20%	-	20%	-	20%	-	20%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Ms.M.R.Sudha, Assistant Professor*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D03T	Course Name	DATA MINING AND WAREHOUSING	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Gain knowledge about Data mining and Knowledge Discovery Process			
CLR-2 :	Practice the Data mining Tools to apply Data mining algorithms			
CLR-3 :	Understand and Apply Association rule mining techniques Understand and Apply various Classification algorithms			
CLR-4 :	Gain knowledge on the concepts of Cluster and Outlier Analysis			
CLR-5 :	Gain knowledge about Data Warehouse manager, Query manager and DW Schema			
CLR-6 :	Understand the partitioning and backup technologies			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLO-1 :	Understand the Data mining concepts and KDD process	2	85	80	*L*	*H*	*H*	*H*	*H*	*M*	-	*H*	*M*	*H*	-	*H*	-	-	-
CLO-2 :	Understand and Apply Association rule mining and classification techniques in real world scenario	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-3 :	Gain knowledge about Cluster & Outlier Analysis	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-4 :	Understand the importance of applying Data mining concepts in different domains	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-5 :	Gain knowledge on Data warehouse and different types of Schema concepts	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-6 :	Understand the partitioning and backup technologies	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	*Why Data mining? What is Data mining?*	*Visualization techniques*	*Introduction to data warehouse architecture*	*Data warehouse partitioning and needs*	*Introduction of data marts*
S-2	SLO-1	*Kinds of data, information and knowledge*	*Measures Likelihood & distance*	*Process architecture: Load manager*	*Horizontal partitioning*	*Estimation of design cost*
S-3	SLO-1	*Data mining tools andapplications*	*Neural Networks, Decisiontree technique*	*Data warehouse manager, Query manager*	*Vertical partitioning Comparison of partitioning*	*Meta data , Explanation of Data mart*

S-4	SLO-1	*Explain data, types of data and its technique*	*Constructing Decision tree for real time applications*	*Query manager*	*Explain partitioning*	*meta data by role play*
S-5	SLO-1	*Explain data, information and Knowledge through real time examples using ppt.*	*ID3 algorithm*	*Data warehouse Objects*	*Hardware partitioning*	*Backup*
S-6	SLO-1	*Knowledge Discovery in Database*	*Genetic algorithm*	*Fact table, Dimension table*	*Software partitioning*	*Types of Backup*
S-7	SLO-1	*Data mining architecture*	*Crossover, mutation techniques*	*Data warehouse users*	*Types of Software partitioning Round robin Partitioning Vertical partitioning*	*Hot and Cold backup*
S-8	SLO-1	*Data mining operations and Issues in Data mining*	*What is neural network? Real- life applications*	*Roles and Responsibity of Data ware house*	*Horizontal partitioning, partitioning dimensions,*	*Sure west online backup*
S-9	SLO-1	*Demonstration on data mining algorithms*	*Demonstration of Neural Networks Decision tree and genetic algorithms*	*Compare and explain OLTPand OLAP*	*Demonstration of partitioning And its types*	*Backup the data warehouse*
S-10	SLO-1	*Anatomy of data mining*	*Clustering, Application of clustering clustering.*	*Data warehouse schema, and its types- Star Schema and its characteristics*	*Design fact tables and its type- Star Design – One Fact or Multiple Facts Drill across Joining facts*	*Disaster recovery procedure and Various recovery models*
S-11	SLO-1	*Data mining task- Descriptive and Classification Functions*	*K- means Clustering Algorithm*	*Snowflake schema and its characteristics*	*Fact table surrogate keys Factless Facts*	*Strategies and Best practices of backup and recovery model.*
S-12	SLO-1	*Learning and types*	*Association Rule Mining and Apriori algorithm*	*Factconstellation schema and its characteristics with examples*	*Design summary table*	*Testing and types*

Learning Resources	*1.Prabhu S, Venkatesan N (2006), Data Mining & Warehousing– New Age International – First Edition, New Delhi.* *2.Sam Anahory, Dennis Murray (2004), Data warehousing inreal world – Pearson Education, New Delhi*	*1. Pieter Adriaans, Dolf Zantinge (2005), Data Mining – Pearson education, NewDelhi* *2. Alex Berson, Stephen J Smith (2004), Data Warehousing, Data mining & OLAP –Tata McGraw Hill Publications, New Delhi.*

Learning Assessment											
Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	20%	-	20%	-	20%	-	20%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Mrs.D.S.Dayana , SRMIST*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	*PAD21S01J*	Course Name	MACHINE LEARNING FOR DATA SCIENCE	Course Category	S	Skill Enhancement Course	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning

		1	2	3
CLR-1 :	To develop knowledge on Machine Learning fundamentals	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	To understand and analyse various machine learning models – concepts and techniques			
CLR-3 :	To understand supervised and unsupervised learning concepts			
CLR-4 :	To make decisions and predictions			
CLR-5 :	To find ways to use it to help them grow their business			
CLR-6 :	To make use of predictive causal analytics, prescriptive analytics			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3
CLO-1 :	Gain knowledge about basic concepts of Machine Learning	2	80	70
CLO-2 :	Identify machine learning techniques suitable for a given problem	3	85	75
CLO-3 :	Solve the problems using various machine learning techniques	3	75	70
CLO-4 :	Apply Dimensionality reduction techniques	3	85	80
CLO-5 :	Design application using machine learning techniques	3	85	75
CLO-6 :	Interpret business models and scientific computing paradigms	3	80	70

Program Learning Outcomes (PLO)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fundamental Knowledge	Application of Concepts	Link with Related	Procedural Knowledge	Skills in Specialization	Ability to Utilize Knowledge	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
H	H	H	H	H	M	L	M	H	M	-	H	H	H	M
H	H	H	H	H	M	L	M	H	M	-	H	H	H	M

Duration (hour)		24	24	24	24	24
S-1	SLO-1	*Introduction to Machine Learning*	*Introduction to supervised Learning algorithms –LDA& SVM*	Stochastic Gradient Descent, Naive Bayes, Decision Trees, Ensemblemethods	Multiclass	UnsupervisedLearningAlgorithms
	SLO-2	Definition and types of Machine Learning	Supervised Learning Algorithms	Stochastic Gradient Descent – classification –	Multilabel Algorithms	Clustering
S-2	SLO-1	Machine Learning process	Introduction to Linear Regression- Regularised Regression- Auto Selection of parameters	regression Stochastic gradient descent for sparse data	Feature selection	overview of Clustering methods

			Evaluation of Best Model representation			
	SLO-2	Stages	Introduction to Classification- Regularised Classification	Complexity – stopping criterion – tips on practical use	Multilabel classification format	K-Means
S-3	SLO-1	Machine Learning Development Lifecycle	Auto selection of parameters- Evaluation of best models- Model representation	mathematical formulation – implementation details	One-vs-the-rest	affinity propagation
	SLO-2	Machine Learning Workflow	Lasso- Multi-task Lasso- Least – Angle Regression	Nearest neighbours – classification	One-vs-one	mean shift spectral
S4	SLO-1	Machine Learning Training Process	Bayesian Regression- Robust regression models	Nearest neighbours regression	error-correcting	hierarchical clustering
	SLO-2	Machine Learning Platforms	Polynomial regression- Evaluation of best models- Model representation	nearest neighbour algorithms	output-codes	DBSCAN
S5-8	SLO-1	Collecting and Manipulating data	Write a program to implement and compare SVM, KNN and Logistic regression algorithm to classify the iPhone purchase records data set. Print both correct and wrong predictions. Java/ Python ML library classescan be used for thisproblem	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test datasets.	Implement multi label in classification	Implement Hierarchical Clustering
S9	SLO-1	Machine Learning in data	Introduction to Random Forest- Auto selection of parameters	nearest centroid classifier	Multioutput regression	OPTICS
	SLO-2	Data Modeling	Bagging and Boosting Models- Model representation	nearest neighbours transformer -	Multioutput classification	**birch – clustering**
S10	SLO-1	Data Processing	Introduction to SVM – Auto selection of parameters – Evaluation of best models – Model representation	neighbourhood – components analysis	Classifier chain	**performance evaluation**
	SLO-2	Architecture for ML in Enterprises	Linear and Quadratic Discriminant Analysis	naive bayes – gaussian naive bayes –	regressor chain	introduction to – Unsupervised Learning

				multinomial naive bayes – complement naive bayes		
S11	SLO-1	Software	Dimensionality reduction using Linear Discriminant Analysis	Bernoulli naive bayes – categorical naive bayes	**feature selection**	Auto selection
	SLO-2	Architecture to Model ML Apps in Production	Mathematical formulation of the LDA and QDA classifiers	out-of-core naive bayes model fitting	removing features with low variance	evaluation of best model representation
S12	SLO-1	Model Machine Learning apps	Mathematical formulation of LDA dimensionality reduction	decision trees – classification – regression	**univariate feature selection**	introduction to dimensional reduction
	SLO-1	ML Reference Architecture	Shrinkage – Estimation algorithms	multi-output problems- – complexity – tips on practical use	Recursive feature elimination	auto selection of parameters
S13 -16	SLO-1	Implementing Data Preprocessing	Write a program to implement Logistic Regression algorithm to classify the housing price data set. Print both correct and wrong predictions. Java/Python ML library classescanbe used for this problem.	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task Calculate the accuracy, precision, and recall for your data set.	Implement the Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs	Compare the results of two algorithms and comment on the quality of clustering
S17	SLO-1	Building Blocks	Kernel ridge regression	tree algorithms – cart – mathematical formulation – minimal cost- complexity pruning	Feature selection using select from model	evaluation of best model
	SLO-2	Evolvable Architectures	Support Vector Machines	ensemble methods – bagging meta- estimator	Univariate Selection	model representation
S18	SLO-1	Migration	Classification	forests of randomized trees	Feature Importance	introduction to nearest neighbours
	SLO-2	Pitfalls of Evolutionary Architecture	Regression	AdaBoost – gradient tree boosting	Correlation Matrix with Heatmap	auto selection of parameters
S19	SLO-1	Anti patterns	Density estimation- novelty detection - Complexity	histogram-based gradient boosting	Feature selection as part of a pipeline	evaluation of best models
	SLO-2	Setting Up ML Solutions	Tips on Practical Use: Kernel functions	voting – classifier	**Select K Best**	Compute a distance value between the item to be classified and every item in the training data-set
S20	SLO-1	Fitness Function and Categories	Mathematical formulation	voting regressor	**Select From Model**	**Euclidean distance**

	SLO-2	.Architecture for Refinement and Production Readiness	Implementation details	stacked generalization	**Cross-Validation on Pipelines**	Model representation
S21 -24	SLO-1	Describing Similarity neighbourhoods	Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.	Construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.	Demonstrate Feature Selection	To implement k-Nearest Neighbour algorithm to classify the iris data set.

Learning Resources	TEXTBOOKS: • Introduction to Machine Learning with Python, By Andreas C. Müller and Sarah Guido, October 2016 • Essential Machine Learning and Pragmatic AI, By Noah Gift, December 2018 :	REFERENCE BOOKS/VIDEOS • Stanford Lectures of Andrew Ng. • Machine Learning Yearning by Andrew Ng, deeplearning.ai, 2018 • Hands-On Unsupervised Learning Using Python, By Ankur A. Patel, March 2019 • Clustering and Unsupervised Learning, By Angie Ma, Gary Willis and Alessandra Stagliano, August 2017

Learning Assessment

Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Mrs.A.Jenita Mary, SRMIST*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PCD21AE1T	Course Name	*Professional Skills and Problem Solving*	Course Category	A	Ability Enhancement Course	L	T	P	C
							1	0	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Career Development Centre			Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1:	*utilise success habits to enhance professionalism*			
CLR-2:	enable to solve problems and to crack competitive exams.			
CLR-3:	understand and master the mathematical concepts to solve types of problem			
CLR-4:	Identify a logically sound and well-reasoned argument			
CLR-5:	*expertise in communication and problem-solving skills*			
CLR-6:	*develop problem solving skills with appropriate strategies*			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*identify success habits and inculcate professional skills*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-2:	*grasp the approaches and strategies to solve problems with speed and accuracy*	2	80	70	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-3:	*collectively solve problems in teams and groups*	2	75	70	H	H	H	H	H	H	H	H	M	H	M	H	H	H	H
CLO-4:	*construe and solve an argument through critical thinking*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-5:	*acquire communication and problem- solving skills*	2	80	70	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-6:	*apply problem solving techniques and skills*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H

Duration (hour)		3	3	3	3	3
S-1	SLO-1	Personal profiling	Creative problem solving method	Case study analysis	Emotional Intelligence	Communication skills
	SLO-2	USP& Personal branding	Techniques	Case study analysis	Personal & social competence	Communication skills
S-2	SLO-1	Assumption and strengthening of an argument	Weakening and Inference of an argument	Conclusion and paradox of an argument	Main idea and structure of a passage	Tone and Style of a passage
	SLO-2	Assumption and strengthening of an argument	Weakening and Inference of an argument	Conclusion and paradox of an argument	Main idea and structure of a passage	Tone and Style of a passage
S-3	SLO-1	Arithmetic: Simple equations	Profit, Loss & Discount	Average	Percentage	Mixtures & alligation
	SLO-2	Equation 1 and equation 2	Interest calculation	Average	Percentage	Mixtures & alligation

Learning Resources	1.Arun Sharma-Quantitative aptitude for CAT, Tata McGraw Hill 2.Dinesh Khattar-The Pearson Guide to QUANTITATIVE APTITUDE for competitive examinations.	3.Manhatten Prep - GRE Reading Comprehension and Essays 4. Seven habits of highly effective people- Steven Covey 5. Manhattan Prep – Critical Reasoning Skills and Techniques

Learning Assessment

	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	30 %	-	30 %	-	30 %	-	30 %	-	30 %	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40 %	-
Level 3	Evaluate Create	30 %	-	30 %	-	30 %	-	30 %	-	30 %	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Scientific Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications etc.,

Course Designers

Experts from Industry	**Internal Experts**	
1.Mr Ajay Zenne, Career Launcher, ajay.z@careerlauncher.com	Mr. P Priyanand, SRMIST	
2. Mr.Pratap Iyer, Study Abroad Mentors, Mumbai, pratap.iyer30@gmail.com	Mrs. Kavitha Srisarann, SRMIST	
	Mr. Harinarayana Rao, SRMIST	
	Dr. A Clement, SRMIST	

SEMESTER – II

Course Code	PAD21201J	Course Name	DATA VISUALIZATION AND CONCEPTS	Course Category	C	Professional Core	L	T	P	C
							3	0	4	5

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
CLR-1 :	Describe real time data dashboards with Tableau	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	Discover the data visualization concepts			
CLR-3 :	Illustrate data elaboration			
CLR-4 :	Creating real time data dash boards			
CLR-5 :	Introducing, installing and configuring Data visualization with Seaborn			
CLR-6 :	Explore Data visualization with Matplotlib, Bokeh,Pygal			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Fundamental Knowledge	Application of Concepts	Link with Related	Procedural Knowledge	Skills in Specialization	Ability to Utilize	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
CLO-1 :	To gather knowledge on Data visualization principles	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	To understand and implement data visualization concepts	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	To understand and implement data visualization using graphs.	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	To understand data dashboards	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	To understand and apply data visualization tools	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-6 :	To implement open source data visualization tool	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-

Duration (hour)		21	21	21	21	21
S-1	SLO-1	Introduction to Tableau Tableau story	Data Visualization Concepts	Data Dashboards using Tableau	Open Source Data Visualization with Seaborn	Open Source Data Visualization with Matplotlib, Bokeh And Pygal
	SLO-2	Tableau Application suite	Storytelling process	Real time dashboard and Tableau for real time dashboard	Introduction to Seaborn and install Seaborn	An Introduction To Matplotlib
S-2	SLO-1	Data Preparation	interpreting context	Real time data for Tableau	Statistical data visualization	analysing Data Using NumPy
	SLO-2	Adding data sources in Tableau The sample dataset	Program for slicing substrings and analysis types	Real time dashboard updates	Simple Univariate distributions configure univariate	analysing Data Using Pandas
S-3	SLO-1	The Tableau Workspace	Program using substring	Dashboard pane	Seaborn Univariate plots	Visualizing data , Univariate distributions
	SLO-2	Working with measures and dimensions	storytelling	Visualizing dashboard updates with Tableau	distribution plots	Bivariate distributions and summary statistics
	SLO-1	Lab 1: Installing Tableau Desktop	Lab 4:Visualize a story	Lab 7: Creating a new dashboard		

S4 - S7	SLO-2				Lab 10: *explore different types of Bivariate distributions*	Lab 13: *summary statistics using native*
S-8	SLO-1	*Working with marks*	*storytelling -who*	*Tableau Dashboard*	*Simple Bivariate distributions*	*Python functions*
	SLO-2	*Data extracts*	*storytelling - what storytelling –how*	*Organizing Tableau Dashboard*	*analyse multiple variable pairs*	*Correlation ,Covariance, Z-score*
S-9	SLO-1	*Editing model's metadata , Data types*	*Visualization for storytelling*	*Organizing Tableau Dashboard*	*Regression plots*	*Summary Statistics using NumPy, SciPy*
	SLO-2	*Working with measures*	*storytelling scenarios*	*Formatting Tableau dashboard*	*Themes. styles in seaborn*	*relevance of data visualization for business*
S-10	SLO-1	*Working with dimensions*	*bar charts, types of bar charts*	Dashboard Actions	*searching for patterns in a dataset*	*libraries for data visualization in python*
	SLO-2	*Adding Hierarchies*	*slope graphs*	Dashboard Titles	*Graphs in Seaborn , Types of Graphs*	*Python data visualization environment*
S11 - S-14	SLO-1	*Lab 2: Working with sample dataset in a Tableau Workspace*	*Lab 5 : Graphical tools for data elaboration*	*Lab 8 : Working with Dashboard*	*Lab 11 : Analyse Bivariate Distribution and multiple variable pairs*	Lab 14: *plot graphs*
	SLO-2					
S 15	SLO-1	*Calculated Fields, Table Calculations*	*storyboarding*	*Data driven decisions - Data driven decisions with Dashboard*	*configuring plot aesthetics normal distribution and outliers*	*using histograms - matplotlib*
	SLO-2	*Data Collection , Checklist for Data Collection*	*Visual selection*	*Interactive Tableau Dashboard Embedding Tableau workbook*	*distributions within categories-part*	*matplotlib libraries for visualization*
S-16	SLO-1	*Creating workbook*	*clutter and clutter elimination Gestalt principle*	*Tableau dashboard starters Tableau dashboard extensions*	*analysing categories with facet grids*	*bar chart using ggplot bokeh and pygal*
	SLO-2	*Saving Workbook*	*story design best practices and tools for storytelling*	*Tableau dashboards and story points*	*analysing categories with facet grids-part Figure plots , Reducing*	*select visualization libraries interactive graphs and image files*
S-17	SLO-1	*Sharing workbook*	*Decluttering , Declutter data visualizations*	*Templates for cloud data sharing your Tableau dashboard*	*introducing colour palettes*	*using scatter plots ,graphs ,barcharts , using box and whisker plots*
	SLO-2	*Data tables, Selecting Data Tables*	*Dashboard storytelling*	Charts. Tableau maps and Placing charts on dashboard	*Choosing colour palettes Color guide*	*using a bubble plot ,chart types, stacked bar plot - animate plots with matplotlib*
S-18 - S-21	SLO-1	*Lab 3: Working with Data Tables*	*Lab 6: Create a story with Tableau*	Lab 9: *building a real time dashboard*	Lab 12: *using colour palettes.*	Lab 15: *plotting in Jupyter notebook*
	SLO-2					

Learning Resources	*Fundamentals of Data Visualization, By Claus O. Wilke, April 2019* *Visual Analytics with Tableau, By Alexander Loth, May 2019*	*Tableau Your Data! Fast and Easy Visual Analysis with Tableau Software, By Daniel G. Murray, November 2013* *Hands-On Data Visualization with Bokeh, By Kevin Jolly, June 2018*

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

CLA – 4 can be from any combination of these: Assignments, Seminars, Short Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Mrs.R.Anita Jasmine*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21202J	Course Name	BUILDING MACHINE LEARNING PIPELINES	Course Category	C	Professional Core Courses	L	T	P	C
							3	0	4	5

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Science		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking	Expected Proficiency	Expected Attainment	Fundamental	Application of	Link with Related	Procedural	Skills in Specialization	Ability to Utilize	Skills in Modeling	Analyze, Interpret	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
CLR-1 :	Simpler processes to update existing models, Less time spent to reproduce models																		
CLR-2 :	Help detect potential biases in the datasets or in the trained models																		
CLR-3 :	Free up development time for data scientists and increase their job satisfaction.																		
CLR-4 :	Automated machine learning pipelines will free up from maintaining existing models.																		
CLR-5 :	Publishing the Trained Model as a Web Service for Inference																		
CLR-6 :	Validating a Recommendation System																		
Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*																		
CLO-1 :	Recognise a data management plan and understand the purpose of a data management using data designing concept,	*3*	*80*	*70*	*L*	*H*	*-*	*H*	*L*	*-*	*-*	*-*	*L*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-2 :	Understand Basics for Data Science , Linear Algebra, Vector Scalar Multiplication – Vector Norms	*3*	*85*	*75*	*M*	*H*	*L*	*M*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-3 :	Understand matrix operations	*3*	*75*	*70*	*M*	*H*	*M*	*H*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-4 :	Determinants – Orthogonal matrices Gaussian distribution – Binomial distribution	*3*	*85*	*80*	*M*	*H*	*M*	*H*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-5 :	Loading ,Scaling and encoding the data	*3*	*85*	*75*	*H*	*H*	*M*	*H*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-6 :	Find principal component using Principal Component Analysis and Normalizing a dataset	*3*	*80*	*70*	*L*	*H*	*-*	*H*	*L*	*-*	*-*	*-*	*L*	*L*	*-*	*H*	*-*	*-*	*-*

Duration (hour)		21	21	21	21	21
S-1	SLO-1	Cloud technologies and Data governance, designing a data governance process	Linear Algebra Basics	Matrix arithmetic , working with matrix, From Scalars and Vectors	Work with Vectors	Loading and exploring a dataset
	SLO-2	managing a Data governance strategy, monitoring a data governance strategy	Linear algebra for Machine learning	Shapes and indexing	Basis and projection of vectors	the binarizer() , the minmaxscaler()
S-2	SLO-1	maintaining a Data governance strategy	Linear Transformations, Intuition	Matrix operations- Addition and Scalar Multiplication	work with – Matrix multiplication	the standard scalar

	SLO-2	Data access governance	Linear Transformations as Vectors and Matrices	Transposition, Matrix Decomposition	Inverse matrix	the normalizer , the maxabsscaler()
S-3	SLO-1	risk and Data safety compliance	Classes of space- scalar	Matrix and PCA-covariant matrix	linear Transformations	label encoding, One-Hot encoding
	SLO-2	governance and its relationship with big data	Vector and its types	Eigen value,		Loading and analyzing a dataset
S 04 - S 07	SLO-1	**LAB :Data collection**	**LAB : Vector addition , vector multiplication**	**LAB : Matrix Transformation in Linear Regression**	**LAB : Creating a Recommendation Engine**	**LAB :Recommending Items Based on Other Items**
	SLO-2					
S-8	SLO-1	why big data requires governance	Vector space , Subspaces	Eigen vector calculation	Gaussian elimination	building and evaluating a Linear Regression mode
	SLO-2	why is Big Data different?	types of Vector space	sparse matrix	Gaussian elimination-Example problem	
S-9	SLO-1	Cloud technologies and Data governance	Operation on vectors-Addition	Tensor Arithmetic	Determinants	scaling and encoding the data
	SLO-2	designing a Data governance process	Subtraction	Hadamard product and Tensors-		Analyzing the effects of pre-processing
S-10	SLO-1	maintaining a data governance strategy	multiplications	Singular-Value Decomposition	Orthogonal matrices	Standardizing continuous data
	SLO-2	Data access governance , Data access patterns		Probability basics and propositions		Loading a dataset,
S 11 - S 14	SLO-1	**LAB : Manipulating data**	**LAB : Covariant matrix**	**LAB :Using KNN describing Similarity neighborhoods**	**LAB :Recommending Another Item**	**LAB :Evaluating a Recommendation System**
	SLO-2					
S-15	SLO-1	data breach prevention – least privilege	Scalar and vector multiplications	random variable	Eigenvectors and Linear Transformations	scaling a dataset
	SLO-2	assign and view effective file system permissions		Central limit theorem	Change of Basis	spotting correlations in a dataset
S-16	SLO-1	create an AWS user and group , vulnerability assessments	Linear product Vector	parameter estimation	Linear Transformations in Different Bases	Principal Component Analysis
	SLO-2	Data classification,, data encryption	Theorems related to linear products	Gaussian distribution	Eigen decomposition	
S17	SLO-1	implement security compliance checking	Vector Norms- Definitions, Examples of Norms	Binomial distribution	**Pseudo inverse**	Normalizing a dataset
	SLO-2	Data access monitoring solutions, logging	Norm Representations			
S 18	SLO-1			**LAB :Tensor**	**LAB :Finding Items to**	

- S 21	SLO-2	**Lab: matrix addition, Matrix subtraction, Matrix multiplication**	**LAB: Eigen value , Eigen vector**	**Hadamard product**	**Recommend**	**LAB : Validating a Recommendation System**

Learning Resources	1. Data Governance: The Definitive Guide, By Evren Eryurek, Uri Gilad, Valliappa Lakshmanan, Anita Kibunguchy and Jessi Ashdown, March 2020 2. Essential Math for Data Science, By Hadrien Jean, November 2020	**1. Feature Engineering for Machine Learning, By Alice Zheng and Amanda Casari, 2018.** **2. Python Feature Engineering Cookbook, By Soledad Galli, January 2020**

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*20%*	*20%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Understand										
Level 2	Apply	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*	*20%*
	Analyze										
Level 3	Evaluate	*10%*	*10%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*	*15%*
	Create										
	Total	100 %		100 %		100 %		100 %		-	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	Ms.A.Rajalakshmi
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D04T	Course Name	MACHINE LEARNING MODEL MANAGEMENT	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	To learn how to Data architects help companies manage, store and secure their data.	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLR-2 :	To learn about SQL and NoSQL databases																		
CLR-3 :	To get a clear understanding about Hadoop																		
CLR-4 :	To get in-depth knowledge of the Big Data framework using Hadoop																		
CLR-5 :	To analyze large data sets to find trends, correlations or other insights not visible with smaller data sets or traditional processing methods.																		
CLR-6 :	To observe various customer related patterns and trends.																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	To gather extensive knowledge in Big Data and its architecture	2	85	80	*L*	*H*	*H*	*H*	*H*	*M*	-	*H*	*M*	*H*	-	*H*	-	-	-
CLO-2 :	To improve and understand ETL process and relevant ETL tools	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-3 :	To differentiate between a batch layer for large volumes of data and a speed layer for real time processing of data streams	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-4 :	To understand Distributed systems	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-5 :	To understand Data modelling techniques	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-6 :	To incorporate data from all sources is key to optimizing the insights gained with Big Data.	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	**ML Model Evaluation and Selection-Introduction**	**MLModel Management Introduction**	**Hyperparameter tuning, versioning**	**Recommendation Algorithms**	**-Recommendation Evaluation and Validation**

S-2	SLO-1	Cross-validation	Creating and saving ML models with scikit-learn	**Deployment -** Hyperparameter tuning with grid search	Recommendation algorithms design	Describing Recommendation Engines
S-3	SLO-1	evaluating estimator performance	Models for Regression	reproducing study	– User-based-Collaborative-Filtering (UBCF) Algorithm	Types of Recommendation Engines
S-4	SLO-1	Computing cross- validated metrics	Getting started with Regression model example	Machine Learning metrics	Collaborative Filtering based Online Recommendation Systems	Comparing the Types of Recommendation Engines
S-5	SLO-1	Cross validation iterators, A note on shuffling, Cross validation and model selection	Classification management	Machine learning model versioning	Item-based Collaborative Filtering (**IBCF)**	Collecting and Manipulating Data
S-6	SLO-1	Tuning the hyper-parameters of an estimator, Exhaustive GridSearch–Randomized – Parameter Optimization	Building machine Learning pipelines	Machine learning Model versioning with git and DVC	Rule- real-life sequential recommendation systems	Describing Similarity and Neighbourhoods
S-7	SLO-1	Alternatives to brute force parameter search– Metrics and scoring, quantifying the quality of predictions–	Overview-Pipelines	Model management framework	SVD algorithm for recommender systems	creating a Recommendation Engine
S-8	SLO-1	defining model evaluation rules– Classification metrics	Machine Learning pipeline Tools	Studio ml setup	An incremental algorithm-Incremental Appro SVD.	Recommending Another Item
S-9	SLO-1	Multilabel ranking metrics, Regressionmetrics,Clusteringmetrics–Dummyestimators–Model persistence	Machine Learning Pipeline Techniques and tools -Example	Machine learning model creation	Singular Value Decomposition VS Matrix Factorization in Recommender Systems.	Finding Items to Recommend
S-10	SLO-1	&maintainability I imitations– Validation curves	Machine Learning Pipeline implementation	Machine learning model in production	collaborative filtering algorithm	Recommending Items Based on Other Items –
S-11	SLO-1	plotting scores to evaluate models	Iterative Machine Learning model	**Deploying model process**	Online Recommendation Systems	Evaluating a Recommendation System –
S-12	SLO-1	Validationcurve– Learningcurve	Comparisons of Different Models	Deployed machine learning model in production	Comparisons	**Validating Recommendation System**

Learning Resources	**1 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, Aurélien Géron, September 2019** **2.Building Recommendation Engine, By Suresh K Gorakala,December 2016**	**1. Hands-On Recommendation Systems with Python: Start Building Powerful and Personalized, Recommendation Engines with Python, Rounak Banik, July 2018**

Learning Assessment											
Level	**Bloom's Level of Thinking**	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		**CLA – 2 (10%)**		**CLA – 3 (20%)**		**CLA – 4 (10%)#**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	20%	-	20%	-	20%	-	20%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Mrs.M.R.Sudha, SRMIST*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D05T	Course Name	NATURAL LANGUAGE PROCESSING	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Science	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
CLR-1 :	Teach students the leading trends and systems in natural language processing.	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-2 :	Make them understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above mentioned concepts.			
CLR-3 :	Teach them to recognize the significance of pragmatics for natural language understanding.			
CLR-4 :	Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.			
CLR-5 :	To conceive basics of knowledge representation, inference, and relations to the artificial intelligence.			
CLR-6	To understand natural language processing and to learn how to apply basic algorithms in this field			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:			
CLO-1 :	Understand approaches to syntax and semantics in NLP.			
CLO-2 :	Understand approaches to discourse, generation, dialogue and summarization within NLP.	2	80	85
CLO-3 :	Understand current methods for statistical approaches to machine translation.	2	75	80
CLO-4 :	Understand machine learning techniques used in NLP, including the probabilistic context-free grammars and unsupervised methods, as applied within NLP	2	85	80
CLO-5 :	Understand the knowledge of various levels of analysis involved in NLP	2	80	75
CLO-6	Gain knowledge in automated Natural Language Generation and Machine Translation	2	75	85

Program Learning Outcomes (PLO)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLO-1 :															
CLO-2 :	H	H	H	H	H	-	-	-	H	M	M	H	H	H	H
CLO-3 :	H	H	H	H	H	-	-	-	H	M	M	H	H	H	H
CLO-4 :	H	L	M	H	H	-	-	-	H	M	M	H	H	H	H
CLO-5 :	H	H	H	H	H	-	-	-	H	M	M	H	H	H	H
CLO-6	H	H	H	H	H	-	-	-	H	M	M	H	H	H	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to NLP	Greedy	Introduction to CFG	Understanding Word Vectors	Information Extraction and its approaches
	SLO-2	Understanding Text	Non Greedy Regular Expressions	Intro to PCFG		
S-2	SLO-1	Text Encoding	POS Tagging	Markov Models	Introduction to LSA	Information Retrieval
	SLO-2	Tokenization	Types of POS tags	Hidden Markov Models		
S-3	SLO-1	Lemmatization	Named Entity Recognition	Data Labeling using NER	Implementation in Python	Semantic Search
	SLO-2	Stemming	Understanding NER			
S-4	SLO-1	Vectorization	Semantic Roll Labeling	CRF	Word Embedding	Summarization
	SLO-2	Vectorization using TF	Understanding Text Parsing	CRF Implementation	Types of Word Embedding	Extractive Vs Abstractive
S-5	SLO-1	Vectorizatin using IDS	Various	Extraction with LDA	Understanding Word to Vector Model	Information Fusion
	SLO-2	Count Vectorizer	Algorithms used in Parsing		Glove Embeddings	Single and Multi Document

S-6	SLO-1	*Uses of NLP*	*NLTK Setup*	*NER*	*Difference between W to V &*	*Introduction to Chat pot Application*
	SLO-2	*Challenges of NLP*		*Standard Libraries*	*ELMO, Fasttext and Glove*	
S-7	SLO-1	*Terminologies of NLP*	*Components of NLP*	*POS Tagging*	*Understanding Machine Translation*	*Retrieval based and Conversation based NLU and NLG*
	SLO-2	*Steps of NLP*				
S-8	SLO-1	*Parsing Approach*	*Tokenization with NLTK*	*NLTK Implementation*	*Understanding Machine Translation*	*Introduction to Probabilistic Approaches*
	SLO-2	*Parsing types*				
S-9	SLO-1	*Corpus*	*Stop words using NLTK*	*Spacy Framework*	*Understanding LDA*	*Statistical Approaches to NLP tasks*
	SLO-2	*Corpus Linguistics*		*Text classification*		
S-10	SLO-1	*Regular Expressions*	*Stemming*	*Analysing and Processing text*	*Understanding LDA*	*Sequence Labeling*
	SLO-2					
S-11	SLO-1	*Regular Expressions in Python*	*Lemmatization*	*Using and Learning scikit*	*NER Application*	*Problems and Similarity Measures*
	SLO-2					*Sentence Embeddings*
S-12	SLO-1	*NLP Libraries*	*Synonyms and Antonyms with NLTK*	*Sentiment Analysis*	*Implementing NER application using Spacy*	*Recurrent Neural Networks*
	SLO-2					

Learning Resources	1. Practical Natural Language Processing, By Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta and Harshit Surana, June 2020 2. Natural Language Processing with Python and spacy, uliVasiliev, April 2020.	3. C.Manning and H.Schutze, ―Foundations of Statistical Natural Language Processingll, MIT Press. Cambridge,MA:,1999 4. Natural Language Processing with Python Quick Start Guide, NirantKasliwal, November 2018 5. YoavGoldberg,Neural Network Methods for Natural Language Processing.

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	20%	-	20%	-	20%	-	20%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	**Mr.J.Venkatasubramanian**
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D06T	Course Name	REINFORCEMENT LEARNING FOR AI	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Artifical Intelligence	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications			Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR): *The purpose of learning this course is to:*

CLR-1 :	To understand the concept of algorithms helps approach problems with simple step by step solutions.
CLR-2 :	To apply creative thinking towards the problem which would help in having a solution-oriented mindset
CLR-3 :	To develop the students, have familiarity with them and stays relevant to the future modern world
CLR-4 :	To develop the abilities creates new opportunities in most business sectors and consumer applications.
CLR-5 :	To develop the decision-making knowledge.

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*

		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLO-1:	Learn how to define RL tasks and the core principals behind the RL, including policies, value functions	3	85	80	M	L	L	-	L	-	L	-	M	L	L	L	M	M	L
CLO-2 :	Implement in code common algorithms following code standards and libraries used in RL	3	80	70	-	L	H	-	H	-	L	-	H	M	H	M	L	M	L
CLO-3 :	Understand and work with tabular methods to solve classical control problems	3	70	65	M	M	H	-	H	-	M	-	M	M	H	M	L	M-	M
CLO-4 :	Explore imitation learning tasks and solutions	3	70	70	H	H	M	-	M	-	M	-	H	L	M	L	M	H	H
CLO-5 :	Recognize current advanced techniques and applications in RL	3	80	70	-	M	M	-	M	-	M	-	H	M	H	M	M	H	M

Duration (hour)		12	12	12	12	12
S-1	**SLO-1**	***Reinforcement learning basics***	***RL formalisms and relations***	***Open AI Gym***	***Deep Q-Networks***	***Learning All possible policies with Entropy Methods***
S-2	**SLO-1**	***Use and applications of RL***	***Rewards in RL***	***The Random Cartpole agent***	***Deep Learning Architecture***	***Maximum Entropy RL***
S-3	**SLO-1**	*Reinforcement learning as MDF*	***Agents in Reinforcement learning***	***The extra Gym Functionality - Wrapper and monitors***	***Deep Q-Learning***	***Soft Actor-Critic***
S-4	**SLO-1**	*Learnable Functions in Reinforcement learning*	***The environnent***	***Deep Learning with PyTorch***	***Rainbow DQN***	***Extension to maximum Entropy Methods***
S-5	**SLO-1**	*Reinforcement learning and machine learning*	***Actions***	***Tensors***	***Example: Rainbow DQN on Atari Games***	***Performance Comparison: SAC Versus PPO***

S-6	**SLO-1**	*Taxonomy of RL Approaches*	***Observations***	***Gradients***	***Other DQN Improvements***	***Industrial Example: Learning to drive with a remote control car***
S-7	***SLO-1***	*Reinforcement learning flow*	***Markov décisions process***	***NN building blocks***	***Policy Gradient Methods***	*Rethinking the MDP*
	SLO-2	*Deep Reinforcement learning Algorithms*	***Inventory Control and control simulation***	***Custom layers***	***Benefits of Learning a Policy Directly***	***Hierarchical RL***
S-8	**SLO-1**	*On-Policy and Off - Policy Algorithm*	***Markov reward process***	***Final glue - loss functions and optimizers***	***Policy Gradient Theorem***	*Multi- Agent RL*
	SLO-2	*The First RL Algorithm*	***Markov decision process***	***Monitoring with Tensor Board***	***n-Step Actor-Critic and Advantage Actor-Critic (A2C)***	*Expert Guidance*
S-9	**SLO-1**	*Compare and contrast RL and ML*	*Rewards* ***Engineering***	***GAN on Atari images***	***Industrial Example: Automatically purchasing products for customers***	*Other Paradigms*
	SLO-2	*State change and transition process*	*Policy Evaluation: The Vale Function*	***The Cross-Entropy Method***	***Beyond Policy Gradients***	*The RL Project Life sysle*
S-10	**SLO-1**	*RL as a Discipline*	*Policy Improvement: Choosing the Best Action*	***Taxonomy of RL methods***	***Off-Policy Algorithms***	*Problem definition in RL*
	SLO-2	***Deep Learning for Reinforcement learning***	*Improving the e-greedy Algorithm*	***Cross entropy on cartpole and Frozem Lake***	***Deterministic policy Gradients***	*RL Engineering and refinement*
S-11	**SLO-1**	***Reinforcement learning and Supervised Learning***	*Policies and Value Functions*	***Theoretical background of the cross-entropy method***	***Trust Region Methods***	*Mapping policies and Action spaces*
	SLO-2	***Lack of an Oracle***	*Discounted Rewards*	***Tabulate Learning and the Bellman equation***	***Using Servos for a Real-Life Reacher***	*Operational RL Implementation and Deployment*
S-12	**SLO-1**	*Sparsity of Feedback*	*Monte Carlo Policy Generation*	***Value, state and optimality***	***Other policy Gradient Algorithms***	*Conclusion and the future Tips and Tricks*
	SLO-2	*Data Generation.*	*Value Iteration with Dynamic Programming*	*Q-Learning for FrozenLake*	***Extensions to policy Gradient Algorithms***	*The future of RL*

Learning Resources	1. Deep Reinforcement Learning Hands-On - Second Edition, Maxim Lapan, January 2020 2. Reinforcement Learning, By Phil Winder, March 2020 3. Foundations of Deep Reinforcement Learning: Theory and Practice in Python, By Laura Graesser and Wah Loon Keng, December 2019.

Learning Assessment											
Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%) #			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*30%*	-	*30%*	-	*30%*	-	*30%*	-	*30%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Short Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
	Experts from Higher Technical Institutions	**Internal Experts**
	Dr.Muthu, Professor, Loyola College, Chennai	***Dr.B.Rebecca Jeyavadhanam***
	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21G01T	Course Name	MATHEMATICS FOR DATA SCIENCE	Course Category	G	Generic Elective Course	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics and Statistics			Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR): *The purpose of learning this course is to:*

		Learning
CLR-1 :	To apply the basic concepts and theorems of matrices	
CLR-2 :	To understand basic mathematical concepts needed for Data Science	
CLR-3 :	To learn the basic concepts of differentiation and integration	
CLR-4 :	To understand and implement linear algebra and matrices concept	
CLR-5 :	To strengthen the knowledge in Calculus and Vector analysis	
CLR-6 :	To equip the students with the knowledge of Mathematics and its applications	

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*

		1	2	3	Program Learning Outcomes (PLO)														
		Level of Thinking	Expected Proficiency	Expected Attainment (%)	1 Scientific Knowledge	2 Problem Analysis	3 Design & Development	4 Analysis, Design,	5 Modern Tool Usage	6 Society & Culture	7 Environment &	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	13 PSO - 1	14 PSO - 2	15 PSO – 3
CLO-1 :	Gain knowledge in basic concepts of matrix method.	3	85	80	L	L	-	L	M	-	-	-	M	M	-	M	-	-	-
CLO-2 :	Understand concepts of linear transformation	3	80	75	M	M	-	H	L	-	-	-	M	M	-	H	-	-	-
CLO-3 :	Understand the concepts of differentiation	3	85	80	M	H	M	H	M	-	-	-	M	M	-	M	-	-	-
CLO-4 :	Acquire the knowledge of applying mathematics in data science	3	85	80	M	H	H	H	M	-	-	-	M	M	-	H	-	-	-
CLO-5 :	Learners will understand the concept of numerical integration	3	85	80	H	H	H	M	M	-	-	-	M	M	-	H	-	-	-
CLO-6 :	To be familiarized with the fundamentals of vector analysis	3	85	80	M	M	H	M	L	-	-	-	L	M		H	-	-	-

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	System of linear equations- Introduction	Linear transformation – Introduction	Characteristic equation	Differentiation - Introduction	Vector analysis – Introduction
	SLO-2	Matrix form of system	Linear transformation –examples	Eigen values of a real matrix	Functions and derivatives	Geometric approach
S-2	SLO-1	Elementary matrix operations	Linear transformation –properties	Eigen values of a real matrix	Multivariate functions	Vector addition by a scalar
	SLO-2	Matrix addition	Matrix transformation of a Linear transformation	Eigen vectors of a real matrix	Multivariate functions - Problems	Vector multiplication by a scalar
S-3	SLO-1	Matrix scalar multiplication	Problems	Eigen vectors of a real matrix	Partial derivatives	Practice problems
	SLO-2	Elementary row operations	Linear transformation corresponding to a matrix problem	Properties of Eigen values	Problems on partial derivatives	Co-ordinate vectors

S 4	**SLO-1**	*Elementary row reduction*	*Change of basis concept*	*Minimal polynomial*	*Line integral*	*Vector addition*
	SLO-2	*Elementary row reduction*	*Isomorphism – Problems*	*Cayley-Hamilton theorem*	*Problems on line integral*	*Properties of vector operations*
S-5	**SLO-1**	*Matrix Echelon form*	*Rank of a Matrix*	*Problems based on Cayley-Hamilton theorem*	*Double integral*	*Transposition operator*
	SLO-2	*Matrix Echelon form*	*Problems on Rank of a Matrix*	*Problems based on Cayley-Hamilton theorem*	*Problems on double integral*	*Practice problems*
S - 6	**SLO-1**	*Practice problems*	*Determinant of a Matrix*	*Invariant sub-spaces*	*Triple integral*	*Norms- Definition and examples*
	SLO-2	*Gauss elimination method*	*Problem on Determinant of a Matrix*	*Matrix - Diagonal forms*	*Problems on triple integral*	*Common vector norms*
S- 7	**SLO-1**	*Problems on Gauss elimination method*	*Theorems on Rank of Matrices*	*Matrix - Diagonal forms - Problems*	*Multiple integration*	*Norm representations*
	SLO-2	*Solving linear system*	*Nullity theorem*	*Matrix - Triangular forms*	*Applications of Multiple integration*	*Problems and applications*
S - 8	**SLO-1**	*Gauss Jordan method*	*Application of Nullity theorem*	*Matrix - Triangular forms*	*Examples of multiple integrals*	*The dot product - Definition*
	SLO-2	*Practice problems*	*Linear functional-Examples*	*Hermitian matrices*	*Polar coordinates*	*Geometric interpretation*
S - 9	**SLO-1**	*Vector spaces-Definition and examples.*	*Linear functional-properties*	*Skew- Hermitian matrices*	*Polar coordinates - Problems*	*Parallel and perpendicular components*
	SLO-2	*Vector space-Simple properties*		*Unitary matrices*	*Cylindrical coordinates*	*Projection*
S - 10	**SLO-1**	*Problems based on vector space*	*Dual space- Definition and examples*	*Practice problems*	*Cylindrical coordinates - Problems*	*Practice problems*
	SLO-2	*Subspaces – Definition and examples*	*Dual space – problems*	*Direct sum decompositions*	*Problems on Cylindrical coordinates*	*Properties of dot product*
S-11	**SLO-1**	*Practice problems*	*Annihilator – Examples*	*Direct sum decompositions - Problems*	*Spherical polar coordinates*	*Commutative property*
	SLO-2	*Linear dependence*	*Annihilator – Problems*	*Invariant direct sum*	*Spherical polar coordinates - Problems*	*Distributive property*
S-12	**SLO-1**	*Linear dependence-Properties*	*Double dual space*	*Primary decomposition theorem.*	*Problems on Spherical polar coordinates*	*Applications of properties*
	SLO-2	*Problems based on linear dependence*	*Transpose of a linear transformation*	*Problems on Primary decomposition*	*Differential expressions*	*Problems on dot product properties*

Learning Resources	***TEXT BOOK:*** • ***E*ssential Math for Data Science, by Hadrien Jean, November 2020** • **Data Science from Scratch, by Joel Grus, April 2015**	*REFERENCE BOOKS:* **Principles of Data Science, by Sinan Ozdemir, December 2016**

Learning Assessment											
Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-	30%	-	30%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	30%	-	30%	-	30%	-	30%	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers	
Experts from Academic	Internal Experts
	J.Madhumitha , Assistant Professor, Department of Mathematics and Statistics

Course Code	*PAD21G02T*	Course Name	DIGITAL MARKETING ANALYTICS	Course Category	G	Generic Elective Course	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the digital marketing analytics on the data captured			
CLR-2 :	Learn tools for performing different digital analytics on the digital marketing data.			
CLR-3 :	Knowing the impact of digital influence and listening			
CLR-4 :	Conducting research on the digital marketing data			
CLR-5 :	Identifying strategies for Mobile analytics and Business Intelligence			
CLR-6 :	Learn techniques for digital marketing analytics			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLO-1 :	Understand the digital media marketing and the need for analytics on the data captured	2	85	80	*L*	*H*	*H*	*H*	*H*	*M*	-	*H*	*M*	*H*	-	*H*	-	-	-
CLO-2 :	Choose the appropriate tools for performing different digital analytics on the digital marketing data.	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-3 :	Analyze and appraise the outcomes of digital influence and listening	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-4 :	Formulate a research plan and perform search analysis on the digital marketing data	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-5 :	Summarize the strategies for Mobile analytics and Business Intelligence	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-6 :	Apply techniques for digital marketing analytics	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		**12**	**12**	**12**	**12**	**12**
S-1	**SLO-1**	DIGITAL MEDIA AND ANALYTICS	TOOLS FOR DIGITAL ANALYTICS	DIGITAL INFLUENCE AND LISTENING	RESEARCH PLAN AND SEARCH ANALYSIS	ROI, MOBILE ANAYTICS AND BUSINESS INTELLIGENCE
	SLO-2	Digital media types	Social Media Listening Tools	Reality of Digital Influence		
S-2	**SLO-1**	Owned social metrics	Evolution of Social Media Listening Tools	Media List - Klout, PeerIndex Online Versus Offline Influence	Launching new product	Return on Investment (ROI)
	SLO-2	Earned social metrics				
S-3	**SLO-1**	Paid searches	Social analytics life cycle	Using the Influencer List	Product life cycle	

	SLO-2		Social media monitoring software	Developing Social Media Listening Program		Return on Engagement, Influence, Experience
S 4	**SLO-1**	Organic Searches	Sysomos Radian6 Visible Technologies	Using Listening Data for Program Planning	Introduction Phase	Tracking ROI
	SLO-2		Zoho social and others	Implementing Listening Program	Growth Phase	
S-5	**SLO-1**	Aligning Digital and Traditional Analytics	Search Analytics Tools	Conversation Audit	Maturity Phase	Understanding measurement fundamentals
	SLO-2		Basics of search	Online Influencers	Formulating research plan	Measurement reporting cadence
S - 6	**SLO-1**	Identifying social media listening tools	Search analytics use cases	Conducting Social brand benchmarking	Developing source list	Mobile Analytics
	SLO-2		Search data	Use of Online data for crisis anticipation	Research methods	Mobile market landscape
S- 7	**SLO-1**	Social media listening tools - Examples	Google trends	Identifying known issues	Constructing reports	Mobile marketing measurement
	SLO-2		YouTube trends		Delivering reports	
S - 8	**SLO-1**	Understanding social media engagement software	Google Adwords , Yahoo clues	Crisis day monitoring and ongoing reporting	Report use cases	Marketing activities
	SLO-2		Collecting insights through search data			Audience/visitor metric
S - 9	**SLO-1**	social media engagement software - Examples	Audience Analysis Tools	Corrections after crisis	Building central repository of information	Mobile app performance
	SLO-2		Audience Analysis Use Cases			
S - 10	**SLO-1**	Social media engagement tools	Audience analysis tool types	Improving customer service	Search analytics for digital strategy	Social CRM
	SLO-2		Audience analysis Techniques - Event Triggers			Social CRM initiative
S-11	**SLO-1**	Social Media Engagement Tools For Small Business	Content Audits-Optimizing Content Distribution	Social customer service conflict	Search analytics for content strategy and planning	Future of Digital Data
	SLO-2	Examples	Analysing Content Consumption. Engagement Analysis Tools			
S-12	**SLO-1**	Social Media Engagement Tools For Small Business	Social Media Engagement Software (SMES), using SMES	Social customer service models	Search analytics for paid advertising	Business Intelligence
	SLO-2	Examples	study of different SMES in the market.			

Learning Resources	1. Chuck Hemann and Ken Burbary, “Digital Marketing Analytics: Making Sense of Con Data in a Digital World”, Que Publishing, 1 edition, ISBN-13: 978-0789750303, 2013. 2. Simon Kingsnorth, “Digital Marketing Strategy: An Integrated Approach to Online Mark Kogan Page Publisher, First edition, ISBN-13: 978-0749474706, 2016.	3. Dave Chaffey, Fiona Ellis-Chadwick, “Digital Marketing – Strategy, Implementatic Practice”, Pearson Education, Sixth edition, ISBN-13: 978-1292077611, 2016. 4. Eric Enge, Andy Crestodina, Larry Kim, Steve Rayson and Chad White, “How the Turn Marketing Analytics Into Effective Marketing Strategies”, Alexa, An Amazon Con https://blog.alexa.com/wp-content/uploads/2016/12/How-to-Pros-Turn-MarketingAnaly into-Effective-Marketing-Strategies-ebook.pdf

Learning Assessment											
Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	20%	-	20%	-	20%	-	20%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Dr.R.Jayashree*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21G03T	Course Name	TIME SERIES ANALYSIS	Course Category	G	Generic Elective	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics and Statistics	Data Book / Codes/Standards		Statistical Table and Graph sheet	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	To provide basic knowledge of times series Analysis
CLR-2 :	To understand the Concepts of Autoregressive moving average and Auto regression
CLR-3 :	To learn the concepts of
CLR-4 :	To acquire the knowledge of Vector Error Correction model
CLR-5 :	To learn the application of ARMA, ARIMA and VAR
CLR-6 :	To understand the concept of forecasting of time series analysis

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	To acquire the knowledge of basic characteristic of time series	3	85	80
CLO-2 :	To understand the concepts of ARMA, ARIMA model	3	80	75
CLO-3 :	To understand the Vector Autoregression model	3	85	80
CLO-4 :	To gain the knowledge of Cointegration, spurious regression and super consistency	3	85	80
CLO-5 :	To acquire the skill of constructing the VECM and VAR model	3	85	80
CLO-6 :	To understand the forecasting techniques for time series	3	85	80

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Scientific Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment &	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
L	L	-	L	M	-	-	-	M	M	-	M	-	-	-
M	M	-	H	L	-	-	-	M	M	-	H	-	-	-
M	H	M	H	M	-	-	-	M	M	-	M	-	-	-
M	H	H	H	M	-	-	-	M	M	-	H	-	-	-
H	H	H	M	M	-	-	-	M	M	-	H	-	-	-
M	M	H	M	L	-	-	-	L	M		H	-	-	-

		Learning Unit / Module 1	Learning Unit / Module 2	Learning Unit / Module 3	Learning Unit / Module 4	Learning Unit / Module 5
Duration (hour)		12	12	12	12	12
S-1	SLO-1	Concepts of Time series	Introduction to stationary process -Linear process– properties,	Stochastic vs. deterministic trends	Introduction of VEC model	Modeling the Break Process
	SLO-2	Objective of time series analysis	Concepts of Auto regression, moving average models	The random walk process	Construction of VEC model	Model Comparisons Under Different Numbers of Breaks
S-2	SLO-1	Components of time series	Problems on moving average	Impulse-response functions and variance decompositions	Cointegrated VAR Models	Uncertainty about Out-of-Sample Breaks

	SLO-2	Simple models of time series	Introduction to ARMA	Example for Impulse-response functions and variance decompositions	Cointegrated VAR structure	No new Break
S-3	**SLO-1**	Zero mean model	Properties of Mean and autocorrelation	Impulse-response functions and variance decompositions	Cointegrated VAR structure	Single out-of-sample Break
	SLO-2	Models with trends and seasonality	ARMA(p, q) Processes The ACF and PACF of an ARMA(p, q) Process.	Impulse-response functions and variance decompositions	Estimation of Cointegrated VAR	Multiple out-of-sample Breaks
S 4	**SLO-1**	General approach to time series modeling	Calculation of the ACVF	Unit root tests	Estimation of Cointegrated VAR	Filtering – filter function
	SLO-2	Stationary models and the auto regression function	Calculation of the ACVF	Spurious regressions	Estimation of Cointegrated VAR	Filtering Sine and cosine - concepts
S-5	**SLO-1**	Sample auto correlation function	Partial Autocorrelation Function	Example for Spurious regressions	Estimation of Cointegrated VAR	Filtering Sine and cosine
	SLO-2	Model for the Lake Huron Data	Spectral Densities – problems	Definition cointegration	Example for estimation of cointegrated VAR	Filtering general series
S - 6	**SLO-1**	Model for the Lake Huron Data	Spectral Densities – problems	Example for cointegration	Example for estimation of cointegrated VAR	Sequential filtering- concepts
	SLO-2	Models in trend and seasonality	Spectral Densities – problems	Example for cointegration	Testing of Cointegrated VAR	Linesr model - Kalman filtering – concept, model construction
S- 7	**SLO-1**	Estimation and Elimination of Trend in the Absence of Seasonality	State space models – ARIMA	Testing Bivariate Cointegrating Relationships	Testing Procedure for Cointegrated VAR	Mean and variance for kalman filtering
	SLO-2	Estimation and elimination of trend	Estimation state-space models	**Dickey-Fuller test- Augmented Dickey-Fuller test**	Testing for Cointegrated VAR - example	Examples for kalman filetering
S - 8	**SLO-1**	Estimation and elimination of trend	State space model with missing values	**Dickey-Fuller test- Augmented Dickey-Fuller test - examples**	Testing for Cointegrated VAR - example	Forecasting using kalman filtering
	SLO-2	Estimation and elimination of seasonal variation	EM algorithm – problem	**Dickey-Fuller test- Augmented Dickey-Fuller test - examples**	Forecasting (Johansen)- model	Application of kalman filtering

S - 9	**SLO-1**	Estimation and elimination of seasonal variation	Forecasting ARMA Processes	***Test on white noise Procedure***	Forecasting (Johansen)-procedure	Application of kalman filtering
	SLO-2	Estimation and elimination of seasonal variation	ARMA(p, q) Processes	Problems on test on white noise	Example Forecasting Johansen	Non-linear model – ARCH model
S - 10	**SLO-1**	Elimination of seasonal variation in trend	Properties – causality	Problems on test on white noise	Example Forecasting Johansen	GARCH – definition, construction
	SLO-2	Elimination of both trend and seasonal components	ACF and PACF of the ARMA model	Spurious Regression procedure	Example Forecasting Johansen	Mean, variance, autocorrelation
S-11	**SLO-1**	Eliminating the noise sequence	ACF and PACF of the ARMA model – problems	Spurious Regression - problems	Example Forecasting Johansen	GACH Model of Order p, q GARH(p,q):
	SLO-2	Eliminating the noise sequence	ACF and PACF of the ARMA model – problems	Spurious Regression - problems	Forecasting and Granger Causality in a VAR model	Interpretation of GACH
S-12	**SLO-1**	Eliminating the noise sequence	Forecasting of ARMA model	Causes of spurious regression	Granger Causality in a VAR procedure	Application of GACH
	SLO-2	Eliminating the noise sequence	Forecasting of ARMA model	Causes of spurious regression	Granger Causality in a VAR example	Application of GACH

Learning Resources	***Theory:*** *1.* **B V Vishwas and ASHISH PATEL, Hands-on Time Series Analysis with Python: From Basics to Bleeding Edge Techniques, August 2020**	*2.***. Aileen Nielsen, Practical Time Series Analysis, October 2019** ***3.*** Marc S. Paolella, Linear Models and Time-Series Analysis, December 2018

	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA 1 (10%)		**CLA 2 (10%)**		**CLA 3 (20%)**		**CLA 4 (10%)**			
		Theory	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**	**Theory**	**Practice**
Level 1	Remember Understand	30%	-	30%	-	30%	-	30%	-	30%	-
Level 2	Apply Analyze	40%	-	40%	-	40%	-	40%	-	40%	-
Level 3	Evaluate Create	30%	-	30%	-	30%	-	30%	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers	
Experts from Academic	**Internal Experts**
	M.Kalaivani, Assistant Professor, Dept. of Mathematics & Statistics, SRMIST, KTR

Course Code	PAD21S02J	Course Name	Artificial Intelligence	Course Category	S	Skill Enhancement Course	L	T	P	C
							3	0	4	5

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLR-1 :	To understand the Artificial Intelligence																		
CLR-2 :	To learn the basics of Artificial Intelligence and its importance																		
CLR-3 :	To learn about Convolutional Neural Network, Architecture and tools for implementing CNN.																		
CLR-4 :	To learn Recurrent Neural Network and sequence modeling concepts																		
CLR-5 :	To learn about Natural Language Processing And Deep Learning .																		
CLR-6 :	To learn the Reinforcement Learning technique and tools used for implementing																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Able to get knowledge about the importance of Artificial Intelligence	2	85	80	*L*	*H*	*H*	*H*	*H*	*M*	-	*H*	*M*	*H*	-	*H*	-	-	-
CLO-2 :	Able to think about challenges and pitfalls of Artificial Intelligence	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-3 :	Able to Create convolutional neural network using tools	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-4 :	Construct the Recurrent Neural Network using tools	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-5 :	Able to do text analysis using natural language processing techniques and libraries	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-6 :	Construct the model using Reinforcement Learning technique and supporting tools	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-

Duration (hour)		21	21	21	21	21
S-1	SLO-1	Introduction to AI	KNOWLEDGE REPRESENTATION	INFERENCE AND LEARNING	PRODUCTION SYSTEM AND PLANNING	EXPERT SYSTEM
	SLO-2	Challenges of AI	Introduction to Game Playing	Inference	Introduction to Production system	Introduction
S-2	SLO-1	The importance of training	Alpha Beta Pruning	Forward and Backward Chaining	Control strategies	Architecture of Expert System
S-3	SLO-1	AI- Agents and Environments	Knowledge Representation using First order logic	Unification	Rete Algorithm	Roles of Expert System
S 4 –	**SLO-1**					

S 7		**Lab 1: Solving Problems using AI**	**Lab 4: Working on Knowledge Representation-I**	**Lab 7: Working on Forward and Backward Chaining**	**Lab 10: Working on Rete Algorithm**	**Lab 13: Working on basic Expert System-I**
S-8	**SLO-1**	Search strategies in AI	Knowledge Engineering in First Order Logic	Uncertainty	Planning-STRIPS	Typical Expert System
S-9	**SLO-1**	Uninformed Search Strategies	Knowledge Engineering in Proportional Logic	Inference in Bayesian Network	Planning with state space search	MYCIN
S-10	SLO-1	Uninformed Search Algorithms	Proportional vs First Order Logic	Learning from Observations	Partial Order Planning	XOON-DART
S 11 – S 14	**SLO-1**	**Lab 2: Working on Uninformed Search Strategies**	**Lab 5: Working on Knowledge Representation - II**	**Lab 8: Working on Inferences in Bayesian network**	**Lab 11: Working on State Space Search**	**Lab 14: Working on basic Expert System - II**
S-15	SLO-1	Informed Search Strategies	Resolution	Forms of Learning	Planning Graphs	Case Study Construction of simple reflex agent with sensor and actuator using Arduino
	SLO-2	Local Search Algorithm		Inductive Learning		
S-16	**SLO-1**	Problem Formulation	Structured representation of Knowledge Using Scripts	Neural Network-Learning Decision trees	Uses of Planning Graphs	Elements in the Process
S-17	**SLO-1**	Constraint Satisfaction Problem	Structured representation of Knowledge Using Frames	Reinforcement Learning	Planning & acting in the real world	Interaction between elements
S 18 – S 21	**SLO-1**	**Lab 3: Working on Informed Search Strategies**	**Lab 6: Working on Structured representation of Knowledge Using Scripts and Frames**	**Lab 9: Working on Decision Trees**	**Lab 12: Working on Sentiment analysis**	**Lab 15: Working on Expert System - III**

Learning Resources	1. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 3rd Edition, Pearson Education / Prentice Hall of India, 2010. 2. Joseph C. Giarratano , Gary D. Riley ,”Expert Systems : Principles and Programming”,4th Edition, 2015. 3. Nils J. Nilsson, “Artificial Intelligence: A new Synthesis”, Harcourt Asia Pvt. Ltd., 2000. CURRICULUM AND SYLLABUS B.TECH. – DATA SCIENCE 79	4. Janakiraman, K. Sarukesi, ‘Foundations of Artificial Intelligence and Expert Systems’, Macmillan Series in Computer Science, 2000. 5. W. Patterson, ‘Introduction to Artificial Intelligence and Expert Systems’, Prentice Hall of India, 2003. 6. Prateek Joshi, “Artificial Intelligence with Python”, Packt Publishing, 2017. 7. https://www.pdfdrive.net/artificial-intelligence-a-modern-approach-3rd-editione32618455.html

Learning Assessment											
Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	*Dr.B.Rebecca Jayavadhanam*
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PCD21AE2T	Course Name	GENERAL APTITUDE FOR COMPETITIVE EXAMINATIONS	Course Category	A	ABILITY ENHANCEMENT COURSE	L	T	P	C
							1	0	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Career Development Centre	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1:	recapitulate fundamental mathematical concepts and skills			
CLR-2:	provide context - based vocabulary enhancement			
CLR-3:	sharpen logical reasoning through skilful conceptualization			
CLR-4:	familiarize with basic grammatical and syntactical rules			
CLR-5:	enable to solve problems and to crack competitive exams			
CLR-6:	develop new strategies to enhance reading comprehension			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)															
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*build a strong base in the fundamental mathematical concepts*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-2:	*acquire strategies to build vocabulary*	2	80	70	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-3:	*apply the learn conditions towards solving problems analytically*	2	75	70	H	H	H	H	H	H	H	H	M	H	M	H	H	H	H
CLO-4:	*learn grammatical and syntactical rules*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-5:	*grasp the approaches and strategies to solve problems with speed and accuracy*	2	80	70	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-6:	*improve reading comprehension strategies*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H

Duration (hour)		3	3	3	3	3
S-1	SLO-1	Logical Reasoning I	Vocabulary from inference to meaning	Numbers - I	Error Identification - I	Data Sufficiency
	SLO-2	Solving Problems	Vocabulary from inference to meaning	Numbers - I	Error Identification - I	Data sufficiency
S-2	SLO-1	Logical Reasoning – I	Cloze passage	Numbers - II	Error Identification - II	Data Interpretation
	SLO-2	Solving Problems	Cloze passage	Numbers - II	Error Identification - II	Data Interpretation
S-3	SLO-1	Logical Reasoning – I	Sentence Completion	Numbers - III	Sentence Correction - I	Sentence Correction - II
	SLO-2	Solving problems	Sentence Completion	Numbers - III	Sentence Correction - I	Sentence Correction - II

Learning Resources	1. Quantitative aptitude – r s Agarwal 2. Quantitative aptitude – ARUN SARMA	3. ManhattanPrepGMAT Sentence Correction Guide–Avi Gutman 4. GRE Contextual.Vocabulary–Ken Springer

Learning Assessment

	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	30 %	-	30 %	-	30 %	-	30 %	-	30 %	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40 %	-
Level 3	Evaluate Create	30 %	-	30 %	-	30 %	-	30 %	-	30 %	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Scientific Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications etc.,

Course Designers

Experts from Industry	Internal Experts	
1. Mr Nishith Sinha, dueNorth India Academics LLP, Dehradun, **nsinha.alexander@gmail.com**	*1. Dr.P.Madhusoodhanan SRMIST*	3. Dr. A Clement, SRMIST
2.Mr Ajay Zenner, Career Launcher, **ajay.z@careerlauncher.com**	2. Dr.M.Snehalatha SRMIST	4. Dr. J Jayapragash, SRMIST

SEMESTER III

Course Code	*PAD21301J*	Course Name	DEEP LEARNING FOR DATA SCIENCE	Course Category	C	Professional Core Course	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Develop knowledge of Neural Network	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Fundamental Knowledge	Application of Concepts	Link with Related Disciplines	Procedural Knowledge	Skills in Specialization	Ability to Utilize Knowledge	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
CLR-2 :	Understand and analyze deep learning																		
CLR-3 :	Perform Optimization Techniques																		
CLR-4 :	Implement Deep Learning models																		
CLR-5 :	Get Familiar with Keras library																		
CLR-6 :	Implement Deep Q-Learning																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Build a Perceptron model	2	85	80	H	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-2 :	Build Neural Network model using BP algorithm	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-3 :	Using Pytorch to build a prediction model	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-4 :	Fine Tuning the Deep Learning models for performance optimization	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-5 :	Build, Compile, Test, and evaluate model in Keras	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-6 :	Work with Generative Adversarial Networks	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H

Duration (hour)		24	24	24	24	24
S-1	SLO-1	*Introduction to Neural Network*	Fine Tuning NN models ANN Processing Components	Fine Tuning NN Models What is Fine Tuning?	Keras and DL Overview of TFMA	Interactive Applications of DL
	SLO-2	*Fundamentals*	Learning and Training in ANN	Regularization	Practical Consideration for DL	Machine Vision – CNN
S-2	SLO-1	*Biological NN Vs ANN*	Cluster analysis in ANN	What is Vector Quantization?	DL parameters	Pooling Layers
	SLO-2	*ANN Architecture*	NN Building blocks	The Encoder-Decoder Model	Data Loading and Preprocessing	Lenet-5 in Keras
S-3	SLO-1	*Computational Models in NN*	Perceptron to Deep NN	The Generalized Lloyd Algorithm	Data Preprocessing with Keras	Alexnet and vggnet in keras

	SLO-2	*Neurons Interconnection*	Model and Hyper parameters	Relation between SOM and noisy encoder-decoder	Keras Layers	Natural Language processing
S-4	SLO-1	*Threshold Functions*	Classification with NN	Voronoi Tesselation	Training Models with fit()	Creating word embeddings with word2vec
	SLO-2	*Activation functions & ANN*	Deep Learning Frameworks	LVQ Introduction	Monitoring Performance Metrics	Natural Language Classification with familiar networks
S 5-8	SLO-1	Lab 1: Implement a Feed Forward Neural Network with Back propagation training algorithm for realizing XOR problem	Lab 4: Build a NN model using PyTorch	Lab 7: Implement LVQ Network for Pattern Classification	Lab 10: Build a model for Credit Card Fraudulence Detection	Lab 13: Build a CNN model for Image Classification
	SLO-2					
S-9	SLO-1	*Implementing Neural Networks Building Neural Networks Models*	NN Categorization	The LVQ Algortihm	Checkpointing	Generative Adversarial Networks
	SLO-2	*Use case of ANN*	NN Computational Model	The LVQ2 Algorithm	Debugging the model with eager execution	Essential GAN Theory
S-10	SLO-1	Perceptrons	NN Building Components	Hebbian Learning	Speed Up process with multiple GPUs	The Discriminator Network
	SLO-2	Single Layer Perceptron Model	Evolutionary Algorithm & Gradient Descent	Hebbian Learning Rule	Multiple GPU and distributed trainings	The Generator Network
S-11	SLO-1	Least Mean Square Algorithm	Object Image Classification	Competitive Learning	Transfer Learning	The Adversarial Network
	SLO-2	Learning Curves	Learning rates and Optimization	Optimizing NN	Image classification	GAN Training
S-12	SLO-1	Learning Rates	Optimizing Speed	Debugging NN	Keras Metrics	Reinforcement Learning
	SLO-2	Perceptron	Dense Network Tuning using Hyper parameters	Learning rate optimization	Jupyter notebooks	Reinforcement Learning Process steps
S 13-16	SLO-1	Lab 2: Implement a Perceptron in Python	Lab 5: Implement ANN Training in Python for MNIST Digit Classification problem	Lab 8: Using Keras, perform rate adaption schedule.	Lab 11: Work on a text classification problem with Keras API	Lab 14: Design and build a Game environment
	SLO-2					
S-17	SLO-1	Multilayer Perceptron	Linear Model with Estimators	Optimizing Networks	Dataset for NN	Deep Reinforcement Learning Applications
	SLO-2	The XOR Problem	NN for Predictions	Rate adaption schedule	Exploring the Dataset	Deep RL Use cases
S-18	SLO-1	Back Propagation Algorithm	Optimization approaches for prediction	Scaling	Preparing the dataser	Deep-Q Learning Introduction
	SLO-2	Heuristics for improving BP algorithm	NN algorithms	Scaling methods	Visualizing the dataset	The DQN Agent
S-19	SLO-1	Radial Basis Function Networks	Data preparation for NN	Batch Normalization	Compiling the model	Q-Learning
	SLO-2	Interpolation	ANN Training in python	Mini Batch Normalization	Training the NN	Deep Q Learning
	SLO-1	Regularization	Training Samples	Internal Covariate Shift	Testing the NN	Steps in Deep Q Learning

S-20	SLO-2	Learning Strategies	Overfitting and Underfitting	Implement Gradient learning	Evaluate the model	Experience Replay
S 21-24	SLO-1 SLO-2	Lab 3: Implement a Feed Forward Neural Network with Back propagation training algorithm for realizing Straight line e.g. y = 2x + 3	Lab 6: Perform Hyper parameter tuning in the ANN model implemented in Lab 5	Lab 9: Implement Batch Normalization and gauge its performance	Lab 12: Build a DL model for diabetes classification problem	Lab 15:Build and Train the Deep Q Neural Network

Learning Resources	**1. Deep Learning with Python,By Francois Chollet, December 2017** **2. Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence,By Jon Krohn, Grant Beyleveld and Aglaé Bassens, September 2019** **3. Hugo Larochelle's Video Lectures on Deep Learning**	**4. Introduction to Deep Learning by Sandro Skansi, Springer, 2018** **5. Deep Learning withTensorFlow 2 and Keras - Second Edition,By Antonio Gulli, Amita Kapoor and Sujit Pal, December 2019**

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	Mrs. M.Ramla, Assistant Professor,SRM IST
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21302T	Course Name	Enterprise Machine Learning	Course Category	C	Professional Core Course	L	T	P	C
							4	0	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Understand the basic concepts and techniques of Machine Learning			
CLR-2 :	Develop skills of using recent machine learning software for solving practical problems			
CLR-3 :	Understand and implement machine learning AWS, Azure and GCP platform			
CLR-4 :	Understand and Apply Machine Learning in Gaming development			
CLR-5 :	Understand the Decision tree, Random Forest and Naïve Bayes Algorithm			
CLR-6 :	Gain knowledge about Knowledge representations and Predicate logic			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLO-1 :	Understand and implement machine learning AWS, Azure and GCP platform	2	85	80	*L*	*H*	*H*	*H*	*H*	*M*	-	*H*	*M*	*H*	-	*H*	-	-	-
CLO-2 :	Develop knowledge on machine learning in enterprise, and data compliance strategies	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-3 :	Gain experience of doing independent study and research	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-4 :	Understand and Apply real time problem using Machine Learning	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-5 :	Understand the Decision tree and Random Forest and Naïve Bayes Algorithm	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-
CLO-6 :	Gain knowledge about Knowledge representations and Predicate logic	3	85	80	*L*	*H*	*H*	*H*	*H*	-	-	*M*	*M*	*L*	-	*H*	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Infrastructure for data and process, Machine learning and Data pipeline	Cloud and Machine Learning, Machine Learning Workflow Comparison	Azure machine Learning tools And capabilities, Comparing Azure ML Studio and AZURE ML Service	GCP machine learning tools and capabilities, Google Cloud Platform ML capabilities	Role of refactoring, Technical debts, Refactoring techniques, PyCharm for refactoring
S-2	SLO-1	Machine learning models	AWS Machine	Creating & Configuring Azure ML Service workspace	Training and job execution with Google Cloud and Console, BigQuery	Code analysis and refactoring Design principles, Refactoring Principles and Challenges

S-3	SLO-1	Machine learning visualization	Learning Tools and Capabilities	Creating & Configuring Azure ML Service workspace	Training and job execution with Google Cloud and Console, BigQuery	Code analysis and refactoring Design principles, Refactoring Principles and Challenges
S-4	SLO-1	Machine learning frameworks and tools, Metadata and Governance	Cloud Machine Learning Implementation and Comparison	Building ML pipelines with AZURE ML Service, Working With Azure ML Studio	ML features, Implementing models with BigQuery ML	Principles of good code, Refactoring python code
S-5	SLO-1	Risk mitigation, Data compliance issues, Data regulations	Generating Machine Learning based Object detection	Using Azure ML Service Visual Interface, Working With Azure Open Datasets	ML workflow challenges and Serverless approach	Code optimization, Using rope to refactor, Anti-patterns in code
S-6	SLO-1	The importance of global standards	Amazon Machine Learning Console	AZURE MLOps, AZURE ML Notebooks	ML implementation with cloud Datalab , Google AI platform	Machine Learning types
S-7	SLO-1	Risk and Company standards	Amazon SageMaker Architecture	AZURE MLOps, AZURE ML Notebooks	ML implementation with cloud Datalab , Google AI platform	Machine Learning algorithm design
S-8	SLO-1	Myths and Facts of data compliance	Using Amazon SageMaker, Lex , Polly And Transcribe	Pipelines with AZURE data Lake And Azure ML	Features and Components	Impact of refactoring on Machine Learning, Algorithm design
S-9	SLO-1	Compliance training for users	Using Amazon SageMaker, Lex , Polly And Transcribe	Pipelines with AZURE data Lake And Azure ML	Google Cloud AutoML features	Machine Learning algorithm comparison
S-10	SLO-1	Compliance training for management	Amazon SageMaker Neo	CI /CD For Machine Learning with AZURE Pipeline	Managing dataset	Refactor machine, Learning code,
S-11	SLO-1	The benefits of a data compliance program	Augmented Manifest in SageMaker	CI /CD For Machine Learning with AZURE Pipeline	Using AutoML tables	Managing technical debt in machine learning
S-12	SLO-1	Elements of a good compliance strategy, Building a compliance strategy, Reporting and Response procedures	Amazon SageMaker Model Tuning , Amazon SageMaker	Using Microsoft Devlabs Extension	Training models and predicting with AutoML tables, Google cloud AutoML natural language	SonarQube and code coverage, Automatic clone refactoring

Learning Resources	1. *Mastering Azure Machine Learning, By Christoph Korner and Kaijisse Waaijer, April 2020.* 2. *Hands-On Machine Learning on Google Cloud Platform,By Giuseppe Ciaburro, V Kishore Ayyadevara and Alexis Perrier, April 2018.*	*1. Learning Path: AWS Certified Machine Learning-Specialty ML, By Noah Gift, April 2019.*

Learning Assessment											
Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	40%	-	40%	-	40%	-	40%	-
	Analyze										
Level 3	Evaluate	20%	-	20%	-	20%	-	20%	-	20%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D07J	Course Name	CLOUD COMPUTING	Course Category	D	Discipline Elective Course	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLR-1 :	An overview of Distributed Systems and its algorithm.																		
CLR-2 :	To understand the concepts of Cloud Computing and Learn about various public cloud services																		
CLR-3 :	To explore about Web Services and Service Oriented Architecture.																		
CLR-4 :	To learn about Cloud Management Products, Cloud Storage and Cloud Security.																		
CLR-5 :	To know about Google App Engine, AWS and Azure.																		
CLR-6 :	To Learn about Cloud Computing Ideologies, Paradigm and its implementation.																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Implement various Distributed algorithms.	3	80	70	L	H	H	H	H	M	-	H	M	H	-	H	-	-	-
CLO-2 :	Use Google collaboration tools and several public cloud services.	3	85	75	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-3 :	Recognize and Implement the Levels of Virtualization.	3	75	70	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-4 :	Use security tools, finding the vulnerabilities and also to Generate a detailed report.	3	85	80	L	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-5 :	Install and configure Open Stack and launch VMs in AWS and Azure.	3	85	75	M	H	H	H	H	-	-	M	M	L	-	H	-	-	-
CLO-6 :	Gain an insight of Cloud Computing its Implementation, Management and Security.	3	80	70	M	H	H	H	H	M	-	M	M	L	-	H	-	-	-

Duration (hour)		24	24	24	24	24
S-1	SLO-1	*Introduction to Distributed Systems*	*Introduction to Cloud Computing*	*Introduction to Web Service and Service Oriented Architecture*	*Resource Provisioning and Methods*	*HDFS MapReduce*
S-2	SLO-1	*Characteristics*	*Evolution of Cloud Computing*	*SOAP – REST – Basics of Virtualization*	*Cloud Management Products*	*Google App Engine (GAE)*
S-3	SLO-1	*Issues in Distributed Systems*	*Cloud Characteristics- Elasticity in Cloud*	*Full and Para Virtualization*	*Cloud Storage – Provisioning Cloud Storage*	*Programming Environment for GAE*
S-4	SLO-1	*Issues in Distributed Systems*	*Cloud Characteristics- Elasticity in Cloud*	*Full and Para Virtualization*	*Cloud Storage – Provisioning Cloud Storage*	*Programming Environment for GAE*

S-5 – S-8	SLO-1	Lab 1: Practical - Implement RPC and Bankers algorithm.	Lab 4: Use Google collaboration tools: Create Google Docs, Sheets and Slides and share it with other users.	Lab 7: Create a simple web service using Python Flask/Java/any language [Web Service: Client-server model should be implemented using socket/http].	Lab 10: Use security tools like ACUNETIX, ETTERCAP to scan web applications on the cloud.	Lab13: Install and configure OpenStack all-in-one using Devstack/Packstack.
S-9	SLO-1	Distributed System Model	On-demand Provisioning	Implementation Levels of Virtualization	Managed and Unmanaged Cloud Storage	Architecture of GFS
S-10	SLO-1	*Request/Reply Protocols*	*NIST Cloud Computing Reference Architecture*	*Tools and Mechanisms*	*Cloud Security Overview*	*Case Studies: Openstack, Heroku and Docker Containers*
S-11	SLO-1	*RMI*	*Architectural Design Challenges*	*Virtualization of CPU*	*Cloud Security Challenges*	*Amazon EC2*
S-12	SLO-1	*RMI*	*Architectural Design Challenges*	*Virtualization of CPU*	*Cloud Security Challenges*	*Amazon EC2*
S-13 – S-16	SLO-1	Lab 2: Create and distribute a Torrent file to share a file in LAN Environment.	Lab 5: Explore public cloud services like Amazon, Google, Sales Force, Digital Ocean etc	Lab 8:Install Oracle Virtual Box/VMware Workstation and create a chat application [Note: Launch two virtual machines for chat application].	Lab 11: Cloud networks for finding vulnerabilities, verifying leakage of information to an unauthorized third party.	Lab 14: Launch VMs in OpenStack through dashboard.
S-17	SLO-1	*Logical Clocks and Casual Ordering of Events*	*Deployment Models: Public, Private and Hybrid Clouds*	*Memory – I/O Devices*	*Architecture Design – Virtual Machine Security*	*AWS*
S-18	SLO-1	*RPC- Election Algorithm*	*Service Models: IaaS- PaaS – SaaS*	*Desktop Virtualization*	*Security – Application Security*	*Microsoft Azure*
S-19	SLO-1	Distributed Mutual Exclusion	Benefits of Cloud Computing.	Server Virtualization	Data Security	Google Compute Engine.
S-20	SLO-1	Distributed Deadlock Detection Algorithms	Benefits of Cloud Computing.	Server Virtualization	Data Security	Google Compute Engine.
S-21 – S-24	SLO-1	Lab 3: Demonstration and assessment of the implemented algorithms.	Lab 6: Quizzes on different service models and deployment models. Report submission - Comparison of various services provided by different Cloud Service Providers (configuration of VM, cost, network bandwidth etc.).	Lab 9: Review web services implementation - Proper Connection should be established between the client and server to make use of the service offered by the Server. Review the working of application in virtual environment.	Lab12: Report submission - Generate a detailed report describing vulnerabilities along with the suitable action that can be taken to remedy the loopholes.	Lab 15: OpenStack Dashboard should be accessed though web browser. Verify the working of instance by logging into it/pinging the instance.

Learning Resources	*1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems - Principles and Paradigms", Second Edition, Pearson, 2006.* *2. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", John Wiley& Sons, 2011.*	*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. Mukesh Singhal, "Advanced Concepts In Operating Systems", McGraw Hill Series in Computer Science, 1994.* *3.John W.Rittinghouse, James F.Ransome, "Cloud Computing: Implementation "Management, and Security", CRC Press, 2010.*

Learning Assessment

Level	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%) #			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr.G.Muruganandam, Group Project Manager, HCL Technologies, Chennai	Dr.Muthu, Professor, Loyola College, Chennai	***Dr.J.Dhilipan, SRMIST***
Mr.M. Hemachandar, Tech Lead, Wipro Limited, Chennai	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D08J	Course Name	EXPLORATORY DATA ANALYSIS	Course Category	D	Discipline Specific Elective	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Science	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	The essential exploratory techniques for summarizing data with R	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Fundamental Knowledge	Application of Concepts	Link with Related	Procedural Knowledge	Skills in Specialization	Ability to Utilize	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
CLR-2 :	To develop more complex statistical models																		
CLR-3 :	Eliminating or sharpening potential hypotheses about the world that can be addressed by the data																		
CLR-4 :	The plotting systems in R																		
CLR-5 :	The basic principles of constructing informative data graphics																		
Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Making exploratory graphs	2	85	80	H	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-2 :	Principles of analytic graphics	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-3 :	Plotting systems and graphics devices in R	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-4 :	The base and ggplot2 plotting systems in R	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-5 :	Clustering methods	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H
CLO-6 :	Dimension reduction techniques	3	85	80	L	H	H	H	H	H	-	M	M	L	-	H	-	M	H

Duration (hour)		24	24	24	24	24
S-1	SLO-1	*Getting Started with R*	*Principles of Analytic Graphics*	*Plotting Systems*	*Hierarchical Clustering*	*The ggplot2 Plotting System: Part 1*
	SLO-2	*Installation*	*Show comparisons*	*The Base Plotting System*	*Hierarchical clustering Explaination*	*The Basics: qplot()*
S-2	SLO-1	*Getting started with the R interface*	*Show causality, mechanism, explanation, systematic structure*	*The Lattice System*	*How do we define close?*	*Before You Start: Label Your Data*
	SLO-2	*Installing R on Windows*	*Show multivariate data*	*The ggplot2 System*	*Example: Euclidean distance*	*ggplot2 "Hello, world!"*
S-3	SLO-1	*Managing Data Frames with the dplyr package*	*Integrate evidence*	*Graphics Devices*	*Example: Manhattan distance*	*Modifying aesthetics*

	SLO-2	*Data Frames*	*Describe and document the evidence*	*The Process of Making a Plot*	*Example: Hierarchical clustering*	*Adding a geom*
S-4	SLO-1	*The dplyr Package*	*Content, Content, Content*	*How Does a Plot Get Created?*	*Prettier dendrograms*	*Histograms*
	SLO-2	*Installing the dplyr package*	*References*	*Graphics File Devices*	*Merging points: Complete*	*Facets*
S-5 – S-8	SLO-1	*Lab 1:Working on the dplyr package*	*Lab 4:*	*Lab 7:*	*Lab 10:*	*Lab 13:*
	SLO-2					
S-9	SLO-1	*select()*	*Exploratory Graphs*	*Multiple Open Graphics Devices*	*Merging points: Average*	*The ggplot2 Plotting System: Part 2*
	SLO-2	*filter()*	*Characteristics of exploratory graphs*	*Copying Plots*	*Using the heatmap() function*	*Basic Components of a ggplot2 Plot*
S-10	SLO-1	*arrange()*	*Air Pollution in the United States*	*The Base Plotting System*	*K-Means Clustering*	*Example: BMI, PM2.5, Asthma*
	SLO-2	*rename()*	*Getting the Data*	*Base Graphics*	*Illustrating the K-means algorithm*	*Building Up in Layers*
S-11	SLO-1	*mutate()*	*Simple Summaries: One Dimension*	*Simple Base Graphics*	*Stopping the algorithm*	*First Plot with Point Layer*
	SLO-2	*group_by()*	*Five Number Summary*	*Some Important Base Graphics Parameters*	*Using the kmeans() function*	*Adding More Layers: Smooth*
S-12	SLO-1	*Boxplot*	*Boxplot*	*Base Plotting Functions*	*Building heatmaps from K-means solutions*	*Adding More Layers: Facets*
	SLO-2	*Summary*	*Histogram*	*Base Plot with Regression Line*	*further resources*	*Modifying Geom Properties*
S-13 – S-16	SLO-1	*Lab 2: Working on filter, mutate*	*Lab 5: Drawing Graphs and Histograms*	*Lab 8:Applying Plotting functions*	*Lab 11:Implementing K-Means algorithms*	*Lab 14: Working with plotting*
	SLO-2					
S-17	SLO-1	*Exploratory Data Analysis Checklist*	*Overlaying Features*	*Plotting and Color in R*	*Dimension Reduction*	*Modifying Labels*
	SLO-2	*Formulate your question*	*Barplot*	*Colors 1, 2, and 3*	*Matrix data*	*Customizing the Smooth*
S-18	SLO-1	*Read in your data*	*Simple Summaries: Two Dimensions and Beyond*	*Connecting colors with data*	*Patterns in rows and columns*	*Changing the Theme*
	SLO-2	*Check the packaging*	*Multiple Boxplots*	*Color Utilities in R*	*Related problem*	*More Complex Example*
S-19	SLO-1	*Run str()*	*Multiple Histograms*	*colorRamp(),colorRampPalette()*	*SVD and PCA*	*A Quick Aside about Axis Limits*
	SLO-2	*Look at the top and the bottom of your data*	*Scatterplots*	*RColorBrewer Package*	*Unpacking the SVD: u and v*	*Case Study: MAACS Cohort*

S-20	SLO-1	*Validate with at least one external data source*	*Scatterplot - Using Color*	*Using the RColorBrewer palettes*	*SVD for data compression*	*Example: Face data*
	SLO-2	*Try the easy solution first*	*Multiple Scatterplots*	*The smoothScatter() function*	*Components of the SVD - Variance explained*	*Summary of qplot()*
S-21 – S-24	SLO-1 SLO-2	*Lab 3:*	*Lab 6:Working with Scatter Plots*	*Lab 9:Working with Colour Palettes*	*Lab 12:Dimension reduction*	*Lab 15: working with gplot()*

Learning Resources	1. Exploratory Data Analysis with R, Roger D. Peng 2. Unwin, Antony. 2015. Graphical Data Analysis with R. (Links to an external site.)Links to an external site. CRC Press. ISBN 978-1498715232

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %
	Understand										
Level 2	Apply	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %
	Analyze										
Level 3	Evaluate	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Dr.Muthu, Professor, Loyola College, Chennai	**1.** *Dr.Jayashree, SRM IST*
	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21D09J	Course Name	SOCIAL MEDIA AND TEXT ANALYTICS	Course Category	D	*Discipline Specific Elective*	L	T	P	C
							4	0	4	6

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	*The purpose of learning this course is to:*
CLR-1 :	*To leverage the power of the R eco-system to extract, process, analyze, visualize and model social media data*
CLR-2 :	*Visualize and analyze data from social media platforms to understand and model complex relationships using various concepts and techniques*
CLR-3 :	*Understand the fundamentals of text mining*
CLR-4 :	*Utilize text for prediction techniques*
CLR-5 :	*Understand the relevance between information retrieval and text mining*
CLR-6 :	*Analyze different case studies related to text mining*

Course Learning Outcomes (CLO):	*At the end of this course, learners will be able to:*	**Learning**			**Program Learning Outcomes (PLO)**														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Fundamental Knowledge	Application of Concepts	Link with Related Disciplines	Procedural Knowledge	Skills in Specialization	Ability to Utilize Knowledge	Skills in Modeling	Analyze, aInterpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
CLO-1 :	*Understand the basics of social media analytics and R language*	*3*	*80*	*70*	*L*	*H*	*-*	*H*	*L*	*-*	*-*	*-*	*L*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-2 :	*Analyze data from major social media channels such as Twitter & Flickr*	*3*	*85*	*75*	*M*	*H*	*L*	*M*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-3 :	*Acquire knowledge on fundamentals of text mining*	*3*	*75*	*70*	*M*	*H*	*M*	*H*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-4 :	*Perform prediction from text and evaluate it*	*3*	*85*	*80*	*M*	*H*	*M*	*H*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-5 :	*Perform document matching*	*3*	*85*	*75*	*H*	*H*	*M*	*H*	*L*	*-*	*-*	*-*	*M*	*L*	*-*	*H*	*-*	*-*	*-*
CLO-6 :	*Understand how text mining is implemented*	*3*	*80*	*70*	*L*	*H*	*-*	*H*	*L*	*-*	*-*	*-*	*L*	*L*	*-*	*H*	*-*	*-*	*-*

Duration (hour)		**24**	**24**	**24**	**24**	**24**
S-1	SLO-1	Getting Started with R and Social Media Analytics	Visualizing data	Overview of Text Mining	Using Text for Prediction	Finding Structure in a Document Collection
	SLO-2	Understanding Social Media	Managing packages	What's Special About Text Mining?	Recognizing that Documents Fit a Pattern	
S-2	SLO-1	Advantages and Significance of Social Media	Data analytics - Analytics workflow	Structured or Unstructured Data	How Many Documents Are Enough?	Clustering Documents by Similarity

	SLO-2	Disadvantages and Pitfalls of Social Media	Machine learning techniques	Is Text Different from Numbers?	Document Classification	Similarity of Composite Documents
S-3	SLO-1	Social media analytics	Supervised learning, Unsupervised learning	What Types of Problems Can Be Solved?	Learning to Predict from Text	k-Means Clustering
	SLO-2	A typical social media analytics workflow	Text analytics	Document Classification	Similarity and Nearest-Neighbor Methods	
S-4	SLO-1	Data access, Data processing and normalization, Data analysis and Insights	Understanding Twitter, APIs	Information Retrieval	Document Similarity	Hierarchical Clustering
	SLO-2	Opportunities and Challenges	Registering an application	Clustering and Organizing Documents	Decision Rules	
S-5 – S-8	SLO-1	*Lab 1: Simple Text Analytics*	*Lab 4: Text Analytics*	*Lab 7: Working with Classification*	*Lab 10: Working with Document Classification*	*Lab 13: implementing clustering algorithm*
	SLO-2					
S-9	SLO-1	Getting started with R	Connecting to Twitter using R	Information Extraction	Decision Trees	The EM Algorithm
	SLO-2	Environment setup	Extracting sample Tweets	Prediction and Evaluation	Scoring by Probabilities	
S-10	SLO-1	Data types	Trend analysis	From Textual Information to Numerical Vectors	Linear Scoring Methods	What Do a Cluster's Labels Mean?
	SLO-2	Data structures-Vectors		Collecting Documents	Evaluation of Performance - Estimating Current and Future Performance	Applications, Evaluation of Performance
S-11	SLO-1	Arrays	Sentiment analysis	Document Standardization	Getting the Most from a Learning Method	Case Study: Market Intelligence from the Web
	SLO-2	Matrices	Key concepts of sentiment analysis –Subjectivity, Sentiment polarity	Tokenization	Errors and Pitfalls in Big Data Evaluation	
S-12	SLO-1	Lists	Opinion summarization	Lemmatization-Inflectional Stemming	Information Retrieval and Text Mining	Case Study: Lightweight Document Matching for Digital Libraries
	SLO-2	Data Frames	Features	Stemming to a Root	Is Information Retrieval a Form of Text Mining?	
S-13 – S-16	SLO-1	*Lab 2: Working with Data structures*	*Lab 5: Working with Twitter data*	*Lab 8: Information Extraction*	*Lab 11:Decision Trees*	*Lab 14: EM Algorithm*
S-17	SLO-1	Functions - Built-in functions	Sentiment analysis in R	Vector Generation for Prediction	Key Word Search	Mining Social Media
	SLO-2	User-defined functions		Multiword Features	Nearest-Neighbor Methods	
S-18	SLO-1	Controlling code flow - Looping constructs	Follower graph analysis	Labels for the Right Answers, Feature Selection by Attribute Ranking	Measuring Similarity -Shared Word Count	E-mail Filtering

	SLO-2	Conditional constructs	Flickr Data Analysis	Sentence Boundary Determination	Word Count and Bonus, Cosine Similarity	
S-19	SLO-1	Advanced operations	Accessing Flickr's data	Part-of-Speech Tagging	Web-Based Document Search - Link Analysis	Emerging Directions
	SLO-2	apply, lapply	Understanding Flickr data	Word Sense Disambiguation	Document Matching	Summarization
S-20	SLO-1	sapply,tapply	Understanding interestingness – similarities	Phrase Recognition, Named Entity Recognition, Parsing	Inverted Lists	Active Learning
	SLO-2	mapply	Are your photos interesting? - Preparing the data -Building the classifier	Feature Generation	Evaluation of Performance	Learning with Unlabeled Data
S-21 – S-24	SLO-1	*Lab 3: Working with Looping and functions*	*Lab 6: Working with Flickr Data Analysis*	*Lab 9: Phrase Recognition*	*Lab 12: Nearest-Neighbor Methods*	*Lab 15: E-mail Filtering*

Learning Resources	1. Raghav Bali, Dipanjan Sarkar, Tushar Sharma, (2017), "Learning Social Media Analytics with R", Packt Publishing.	2. Sholom M. Weiss, Nitin Indurkhya, Tong Zhang, (2015), "Fundamentals of Predictive Text Mining", Second Edition, Springer London.

Learning Assessment

	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %
	Understand										
Level 2	Apply	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %	20 %
	Analyze										
Level 3	Evaluate	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %	10 %
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

Course Designers

Experts from Industry	**Experts from Higher Technical Institutions**	**Internal Experts**
	Dr.Muthu, Professor, Loyola College, Chennai	Mrs. S. Chandrakala, SRM IST
	Dr.Vincent, Associate Professor, VIT	

Course Code	PAD21P01L	Course Name	INTERNSHIP	Course Category	P	Project Work, Internship In Industry / Higher Technical Institutions	L	T	P	C
							-	-	-	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Demonstrate skills learnt in the real time environment.			
CLR-2 :	Explore the different industries that are using IT			
CLR-3 :	Enhance the skills in the system aspects			
CLR-4 :	Understanding the professional connections with the knowledge learnt			
CLR-5 :	Applying the skills in problem solving			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	1 Disciplinary Knowledge	2 Critical Thinking	3 Problem Solving	4 Analytical Reasoning	5 Research Skills	6 Team Work	7 Scientific Reasoning	8 Reflective Thinking	9 Self-Directed Learning	10 Multicultural Competence	11 Ethical Reasoning	12 Community Engagement	13 ICT Skills	14 Leadership Skills	15 Life Long Learning
CLO-1 :	To get an insight of an industry and organization/company	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	H	H
CLO-2 :	To gain valuable skills and knowledge	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	H	H
CLO-3 :	To make professional connections and enhance networking	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	H	H
CLO-4 :	To get experience in a field to allow the student to make a career transition	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	H	H
CLO-5 :	To get an inside view of an industry and organization/company	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	H	H

Students can choose a company of their own interest for internship for a period of minimum four weeks to learn about the application of IT in real time environment. In the first week of July, all the students have to give a presentation about their observations made by them in internship. At the end of the internship period, every student shall submit a structured internship report within 15 days from the date of the completion of the internship period.

Learning Assessment				
Project Work / Internship	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
	Review – 1	Review – 2	Internship Report	Viva-Voce
	20%	30 %	30 %	20 %

Course Code	PAD21P02L	Course Name	MINI PROJECT WORK	Course Category	P	Project Work, Internship In Industry / Higher Technical Institutions	L	T	P	C
							0	0	8	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards		Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to,	Learning	Program Learning Outcomes (PLO)

		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Demonstrate skills learnt in the real time environment.			
CLR-2 :	Explore the different industries that are using IT			
CLR-3 :	Enhance the skills in the system aspects			
CLR-4 :	Understanding the professional connections with the knowledge learnt			
CLR-5 :	Applying the skills in problem solving			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	Ethical Reasoning	Community Engagement	ICT Skills	Leadership Skills	Life Long Learning
CLO-1 :	To get an inside view of an industry and organization/company	3	80	70	L	H	-	H	L	-	-	-	L	L	-	H	-	-	-
CLO-2 :	To gain valuable skills and knowledge	3	85	75	M	H	L	M	L	-	-	-	M	L	-	H	-	-	-
CLO-3 :	To make professional connections and enhance networking	3	75	70	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-4 :	To get experience in a field to allow the student to make a career transition	3	85	80	M	H	M	H	L	-	-	-	M	L	-	H	-	-	-
CLO-5 :	To get an inside view of an industry and organization/company	3	85	75	H	H	M	H	L	-	-	-	M	L	-	H	-	-	-

Students can choose a company of their own interest for internship for a period of minimum four weeks to learn about the application of IT in real time environment. In the first week of July, all the students have to give a presentation about their observations made by them in internship. At the end of the internship period, every student shall submit a structured internship report within 15 days from the date of the completion of the internship period.

Learning Assessment				
Project Work	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
	Review – 1	Review – 2	Project Report	Viva-Voce
	20%	30 %	30 %	20 %

Course Code	PCD21AE3T	Course Name	Employability Skills	Course Category	AE	Ability Enhancement Course	L	T	P	C
							1	0	0	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Career Development Centre			Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1:	*develop contextual approach to acquire new vocabulary*
CLR-2:	*establish clear relationship between words*
CLR-3:	*identify problems*
CLR-4:	*learn the fundamental skills to solve problems*
CLR-5:	*acquire experience of attending group discussion and personal interview*
CLR-6:	*equipping students with necessary employability skills*

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Disciplinary Knowledge	Critical Thinking	Problem Solving	Analytical Reasoning	Research Skills	Team Work	Scientific Reasoning	Reflective Thinking	Self-Directed Learning	Multicultural Competence	ICT Skills	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
CLO-1:	*determine the accurate meanings of words*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-2:	*recognise parallel relationship between words*	2	80	70	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-3:	*learn to solve problems*	2	75	70	H	H	H	H	H	H	H	H	M	H	M	H	H	H	H
CLO-4:	*understand and applies problem solving skills learned.*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-5:	*inculcate professional communication through Interviews & Group Discussions*	2	80	70	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
CLO-6:	*acquirenecessary skills for successful career*	2	80	75	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H

Duration (hour)		3	3	3	3	3
S-1	SLO-1	Time & work	Time, speed, distance	Permutation and combination	Probability	Geometry and Mensuration
	SLO-2	Solving problems	Solving problems	Solving problems	Solving problems	Solving problems
S-2	SLO-1	Perspective on Issues	Critical Reasoning	Synonyms	Antonyms	Word Analogy
	SLO-2	Perspective on Issues	Critical Reasoning	Synonyms	Antonyms	Word Analogy
S-3	SLO-1	Resume preparation	Group Discussion	Mock GD	Interview Techniques	Mock PI
	SLO-2	Resume preparation	Group Discussion	Mock GD	Interview Techniques	Mock PI

Learning Resources	1. Quantitative aptitude by Dinesh Khattar 2. Ramachandran and Karthik, From Campus to Corporate, India, PEARSON Publication, 2016.	3. Verbal Advantage – Ten Easy Steps to a Powerful Vocabulary – Charles Harrington Elster 4. Barron's GRE

Learning Assessment											
	Bloom's Level of Thinking	**Continuous Learning Assessment (50% weightage)**								**Final Examination (50% weightage)**	
		CLA – 1 (10%)		CLA – 2 (10%)		CLA – 3 (20%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	30 %	-	30 %	-	30 %	-	30 %	-	30 %	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40 %	-
Level 3	Evaluate Create	30 %	-	30 %	-	30 %	-	30 %	-	30 %	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Scientific Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications etc.,

Course Designers		
Experts from Industry	Internal Experts	
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2.**Mr.Pratap Iyer, Study Abroad Mentors, Mumbai,pratap.iyer30@gmail.com**	3. Dr.M.Snehalatha, SRMIST	4. Dr.Jayapragash J, SRMIST
	5. Mr. Harinarayana Rao, SRMIST	6. Mr. P Priyanand, SRMIST
	7. Mrs. Kavitha Srisarann, SRMIST	

SEMESTER IV

Course Code	PAD21P03L	Course Name	PROJECT WORK	Course Category	P	Project Work, Internship In Industry / Higher Technical Institutions	L	T	P	C
							0	0	24	12

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Applications	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	To understand the basics of software development			
CLR-2 :	To know about life cycle of the software development			
CLR-3 :	To explore risk and people management for software development			
CLR-4 :	To learn about different software tools for software development.			
CLR-5 :	To know about different techniques related to software development.			
CLR-6 :	To Learn About documentation process for software development			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Fundamental Knowledge	Application of Concepts	Link with Related Disciplines	Procedural Knowledge	Skills in Specialization	Ability to Utilize Knowledge	Skills in Modeling	Analyze, Interpret Data	Investigative Skills	Problem Solving Skills	Communication Skills	Analytical Skills	ICT Skills	Professional Behavior	Life Long Learning
CLO-1 :	To conceptualize a novel idea / technique into a product	3	80	70	H	H	M	H	L	M	-	H	-	H	-	H	M	-	H
CLO-2 :	To think in terms of multi-disciplinary environment	3	80	75	M	H	M	H	-	M	-	H	-	H	-	H	M	-	H
CLO-3 :	To understand the management techniques of implementing a project	3	85	70	M	H	M	H	-	M	-	H	-	H	-	H	M	-	H
CLO-4 :	To experience on the challenges of teamwork	3	85	80	M	H	M	H	-	M	-	H	-	H	-	H	M	-	H
CLO-5 :	To prepare a presentation in a professional manner	3	85	75	M	H	M	H	-	M	-	H	-	H	-	H	M	-	H
CLO-6 :	To prepare document all aspects of design work.	3	80	70	M	H	M	H	-	M	-	H	H	M	-	H	M	-	H

Students can choose problems of their own interest to develop software package using the programming languages/tools available. There will be two reviews conducted during the project period for all the students .At the end of the project, every student shall submit a structured project report and will take a Viva Voce examination.

Learning Assessment				
	Continuous Learning Assessment (50% weightage)		Final Evaluation (50% weightage)	
Project Work	Review – 1	Review – 2	Project Report	Viva-Voce
	20%	30 %	30 %	20 %

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