Seventh Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	MS-401	Principles of Entrepreneurship Mindset	2		2
PCE		Programme Core Elective Paper (PCE – 4)			4
PCE		Programme Core Elective Paper (PCE – 5)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 3 / OAE – 3)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 4 / OAE – 4)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 5 / OAE – 5)			4
Practical / Viva Voce					
PC / Project	ES-451	Minor Project**			3
PC / Internship	ES-453	Summer Training Report - 2 *			1
Total					**26**

***NUES:**Comprehensive evaluation of the Summer Training Report – 2 (after 6th Semester) shall be done by the committee of teachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

****The student shall be allocated a supervisor / guide for project work at the end 6th semester by the department / institution, the project shall continue into the 8th semester. In the 7th semester evaluation, the criteria for evaluation shall be conceptualization of the project work, the background study / literature survey and identification of objectives and methodology to be followed for project. 40 marks evaluation for the Teachers' Continuous Evaluation / Internal Assessment shall be done by concerned supervisor while the term end examination of 60 marks shall be conducted by the supervisor concerned and the external examiner deputed by the Examinations Division. In the absence of the supervisor, the Director of the Institution / Head of the Department can assign the responsibility of the supervisor (for purpose of examinations) to any faculty of the Institution / Department.

Eight Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Practical / Viva Voce%					
PC / Project	ES-452	Major Project – Dissertation and Viva Voce#			18
	ES-454	Project Progress Evaluation*			2
PC / Internship	ES-456	Internship Report and Viva Voce#			18
	ES-458	Internship Progress Evaluation*			2
Total			**0**	**0**	**20**

***NUES: Comprehensive evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100.**

%By default every student shall do the project work (ES-452 and ES-454). A student shall either be allowed to do a project work (ES-452 and ES-454) or an internship (ES-456 and ES-458). The student must apply for approval to do internship before the commencement of the 8th semester to the institute, and only after approval of Principal / Director of the institute through Training and Placement Officer of the institute, shall proceed for internship.

#Students may be allowed to do internship in this semester in lieu of Major project. The students allowed to proceed for internship shall be required to maintain a log-book of activities performed during internship. The same has to be countersigned by the mentor at the organization where internship is completed.

Programme Core Electives

Semester	Paper Code	PCE – 1 (Choose Any One)	L	P	Credits
6	CIE-306T	Advanced Java Programming	3		3
	CIE-306P	Advanced Java Programming Lab		2	1
6	CIE-308T	Visual Basic.NET Programming	3		3
	CIE-308P	Visual Basic.NET Programming Lab		2	1
6	CIE-312	Engineering Optimization	4		4
6	CIE-320	Principles of Programming Languages	4		4
6	CIE-322T	Simulation and Modelling	3		3
	CIE-322P	Simulation and Modelling Lab		2	1
Semester	**Paper Code**	**PCE – 2 (Choose Any One)**	**L**	**P**	**Credits**
6	CIE-330T	Introduction to Internet of Things	3		3
	CIE-330P	Introduction to Internet of Things Lab		2	1
6	CIE-332T	Programming in Python	3		3
	CIE-332P	Programming in Python Lab		2	1
6	CIE-334	Quantum Computing	4		4
6	CIE-338T	Graph Theory for Computer Science	3		3
	CIE-338P	Graph Theory for Computer Science Lab		2	1
6	CIE-348T	Software Project Management	3		3
	CIE-348P	Software Project Management Lab		2	1
Semester	**Paper Code**	**PCE – 3 (Choose Any One)**	**L**	**P**	**Credits**
6	CIE-354T	Introduction to Digital Signal Processing	3		3
	CIE-354P	Introduction to Digital Signal Processing Lab		2	1
6	CIE-356T	Web Technologies	3		3
	CIE-356P	Web Technologies Lab		2	1
6	CIE-368T	Mobile Computing	3		3
	CIE-368P	Mobile Computing Lab		2	1
6	CIE-370T	Parallel Computing	3		3
	CIE-370P	Parallel Computing Lab		2	1
6	CIE-374T	Artificial Intelligence	3		3
	CIE-374P	Artificial Intelligence Lab		2	1
Semester	**Paper Code**	**PCE – 4 (Choose Any One)**	**L**	**P**	**Credits**
7	CIE-403T	Blockchain Technology	3		3
	CIE-403P	Blockchain Technology Lab		2	1
7	CIE-405T	Data Science	3		3
	CIE-405P	Data Science Lab		2	1
7	CIE-407T	Distributed Systems and Cloud Computing	3		3
	CIE-407P	Distributed Systems and Cloud Computing Lab		2	1
7	CIE-409T	Social Network Analysis and Sentiment Analysis	3		3
	CIE-409P	Social Network Analysis and Sentiment Analysis Lab		2	1
7	CIE-413T	Next Generation Web	3		3
	CIE-413P	Next Generation Web Lab		2	1
Semester	**Paper Code**	**PCE – 5 (Choose Any One)**	**L**	**P**	**Credits**
7	CIE-417T	C#.NET Programming	3		3
	CIE-417P	C#.NET Programming Lab		2	1
7	CIE-419	Intellectual Property Rights	4		4
7	CIE-421T	Machine Learning	3		3
	CIE-421P	Machine Learning Lab		2	1
7	CIE-425T	Data Warehousing and Data Mining	3		3
	CIE-425P	Data Warehousing and Data Mining Lab		2	1
7	CIE-431T	Web Mining	3		3
	CIE-431P	Web Mining Lab		2	1

Emerging Area Elective Groups (for Minor Specialization) – Applicable only for Core Disciplines (EAE)

The minor specialization is offered through a set of five papers that the student has to study to acquire the minor specialization. The number of papers to be studied is two in 6th semester and three in 7th semester. The minor specialization shall be awarded if and only if 20 credits are earned from an individual / specific minor specialization area. From each paper group associated with a paper slot in a particular semester, the student shall be allowed to study only one paper group. The papers shall be allowed to be taken / studied by the students, by the APC of the department / institute, keeping in view that two papers studied by the student should not have a substantial overlap. All papers studied by the student should be substantially distinct in content.

Minor specialization is not necessary for award of the degree, the student may choose five papers from the groups offered by the institution to a particular student (belonging to a major discipline) across groups. Minimum two minor specialization groups should be offered by the institution to students of any particular major discipline from either of the open area or emerging area groups

An elective shall be offered to the student for each Minor Specialization group in Emerging Area (That is for EAE-1, EAE-2, etc.) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective.

Each EAE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of EAE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required. The nomenclature of the paper group is <*ACRONYM OF EMERGING AREA*> - EAE - <SLOT NUMBER>< A or B or C etc., if required>. The major disciplines to which the Emerging Area Elective Group papers can be offered is specified as acronym together with the name of the minor specialization.

In lieu of Emerging Area Elective, students can study papers from Open Area Elective groups also as offered to them.

Emerging Area Specialization: Artificial Intelligence (for CSE / IT / CST / ITE / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	AI-EAE-1	AI-302T	Artificial Intelligence	3		3
		AI-302P	Artificial Intelligence Lab		2	1
6	AI-EAE-2	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
7	AI-EAE-3	SC-401T	Soft Computing	3		3
		SC-401P	Soft Computing Lab		2	1
7	AI-EAE-4	AI-403T	Artificial Intelligence Applications	3		3
		AI-403P	Artificial Intelligence Applications Lab		2	1
7	AI-EAE-5	AI-405T	Intelligent and Expert Systems	3		3
		AI-405P	Intelligent and Expert Systems Lab		2	1

Emerging Area Specialization: Artificial Intelligence and Machine Learning (for CSE / IT / CST / ITE / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	AIML-EAE-1	AI-302T	Artificial Intelligence	3		3
		AI-302P	Artificial Intelligence Lab		2	1
6	AIML-EAE-2	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
7	AIML-EAE-3	ML-407T	Machine Learning	3		3
		ML-407P	Machine Learning Lab		2	1
7	AIML-EAE-4	ML-409T	Reinforcement Learning and Deep Learning	3		3
		ML-409P	Reinforcement Learning and Deep Learning Lab		2	1
7	AIML-EAE-5	ML-411T	Pattern Recognition and Computer Vision	3		3
		ML-411P	Pattern Recognition and Computer Vision Lab		2	1

Emerging Area Specialization: Data Science (for CSE / IT / CST / ITE / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	DS-EAE-1	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
6	DS-EAE-2	AI-316T	Artificial Intelligence and Machine Learning	3		3
		AI-316P	Artificial Intelligence and Machine Learning Lab		2	1
7	DS-EAE-3	DS-427T	Data Science using R	3		3
		DS-427P	Data Science using R Lab		2	1
7	DS-EAE-4	DS-429T	Big Data Analytics	3		3
		DS-429P	Big Data Analytics Lab		2	1
7	DS-EAE-5A OR	DS-431T	Business Intelligence	3		3
		DS-431P	Business Intelligence Lab		2	1
	DS-EAE-5B	DS-433T	Exploratory Data Analytics and Data Visualization	3		3
		DS-433P	Exploratory Data Analytics and Data Visualization Lab		2	1

Emerging Area Specialization: Block Chain Technology (for CSE / IT / CST / ITE/ECE/EE/EEE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	BT-EAE-1	CS-306T	Mathematics of Modern Cryptography	3		3
		CS-306P	Mathematics of Modern Cryptography Lab		2	1
6	BT-EAE-2	BT-308T	Blockchain Technology	3		3
		BT-308P	Blockchain Technology Lab		2	1
7	BT-EAE-3	BT-413T	Bitcoin and Cryptocurrency Technologies	3		3
		BT-413P	Bitcoin and Cryptocurrency Technologies Lab		2	1
7	BT-EAE-4	BT-415T	Smart Contracts	3		3
		BT-415P	Smart Contracts Lab		2	1
7	BT-EAE-5A OR	BT-417T	Blockchain for Cyber Security	3		3
		BT-417P	Blockchain for Cyber Security Lab		2	1
	BT-EAE-5B	BT-419T	Blockchain Technology in Web Development	3		3
		BT-419P	Blockchain Technology in Web Development Lab		2	1

Emerging Area Specialization: Internet of Things (for CSE / IT / CST / ITE / ECE / EE / EEE / ICE / ME)

Emerging Area Specialization: Machine Learning & Data Analytics (for CSE / IT / CST / ITE / ECE / EE / EEE / ICE / ME / CE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	MLDA-EAE-1	DA-304T	Statistics, Statistical Modelling & Data Analytics	3		3
		DA-304P	Statistics, Statistical Modelling & Data Analytics Lab		2	1
6	MLDA-EAE-2A OR	DA-338T	Data Analytics	3		3
		DA-338P	Data Analytics Lab		2	1
	MLDA-EAE-2B OR	DS-340T	Data Visualization	3		3
		DS-340P	Data Visualization Lab		2	1
	MLDA-EAE-2C	ML-342T	Machine Learning	3		3
		ML-342P	Machine Learning Lab		2	1
7	MLDA-EAE-3	ML-463T	Supervised and Deep Learning	3		3
		ML-463P	Supervised and Deep Learning Lab		2	1
7	MLDA-EAE-4	ML-465T	Unsupervised Learning	3		3
		ML-465P	Unsupervised Learning Lab		2	1
7	MLDA-EAE-5A OR	ML-467T	Machine Learning and Data Analytics Case Studies	3		3
		ML-467P	Machine Learning and Data Analytics Case Studies Lab		2	1
	MLDA-EAE-5B	ML-469T	Machine Learning and Data Analytics Frameworks	3		3
		ML-469P	Machine Learning and Data Analytics Frameworks Lab		2	1

Emerging Area Specialization: Software Engineering (for CSE / IT / CST / ITE)

Semester	Paper Group	Paper Code	Paper Name	L	P	Credits
6	SE-EAE-1	SE-350T	Software Measurements, Metrics and Modelling	3		3
		SE-350P	Software Measurements, Metrics and Modelling Lab		2	1
6	SE-EAE-2A OR	SE-352T	Service Oriented Architecture	3		3
		SE-352P	Service Oriented Architecture Lab		2	1
	SE-EAE-2B	SE-354T	Software Project Management	3		3
		SE-354P	Software Project Management Lab		2	1
7	SE-EAE-3	SE-483T	Mining Software Repositories and Predictive Modelling	3		3
		SE-483P	Mining Software Repositories and Predictive Modelling Lab		2	1
7	SE-EAE-4A OR	SE-485	Software Security	4		4
	SE-EAE-4B	SE-487T	Software Verification, Validation and Testing	3		3
		SE-487P	Software Verification, Validation and Testing Lab		2	1
7	SE-EAE-5	SE-489	Software Engineering Standards	4		4

Data Warehousing and Data Mining	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/CST	7	PCE	PCE-5	CIE-425T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the need of data warehousing for data analysis
2.	To understand and apply OLAP operations
3.	To identify the need of various data mining techniques.
4.	To apply various data mining techniques.

Course Outcomes (CO)

CO 1	Able to understand ETL Process.
CO 2	Able to understand and apply OLAP operations for data analysis.
CO 3	Able to apply supervised learning based data mining techniques.
CO 4	Able to apply unsupervised learning based data mining techniques.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	2	2	2	-	-	-	3	2	2	3
CO 2	3	3	2	2	2	-	-	-	3	2	2	3
CO 3	3	3	2	3	3	-	-	-	3	2	2	3
CO 4	3	3	2	3	3	-	-	-	3	2	2	3

UNIT-I

Introduction to Data Warehousing: Overview, Difference between Database System and Data Warehouse, The Compelling Need for data warehousing, Data warehouse – The building Blocks: Defining Features, data warehouses and data marts, overview of the components, Three tier architecture, Metadata in the data warehouse.

Data pre-processing: Data cleaning, Data transformation ETL Process. ETL tools.

Defining the business requirements: Dimensional analysis, information packages – a new concept, requirements gathering methods, requirements definition: scope and content.

UNIT-II

Principles of Dimensional Modelling: Objectives, From Requirements to data design, Multi-Dimensional Data Model, Schemas: the STAR schema, the Snowflake schema, fact constellation schema.

OLAP in the Data Warehouse: Demand for Online Analytical Processing, limitations of other analysis methods-OLAP is the answer, OLAP definitions and rules, OLAP characteristics, major features and functions, hyper cubes.
OLAP Operations: Drill-down and roll-up, slice-and-dice , pivot or rotation, OLAP models, overview of variations, the MOLAP model, the ROLAP model, the DOLAP model, ROLAP versus MOLAP, OLAP implementation considerations. Query and Reporting, Executive Information Systems (EIS), Data Warehouse and Business Strategy.

UNIT-III

Data Mining Basics: What is Data Mining, Data Mining Defined, The knowledge discovery process (KDD Process), Data Mining Applications- The Business Context of Data Mining, Data Mining for Process Improvement, Data Mining as a Research Tool, Data Mining for Marketing, Benefits of data mining,
Major Data Mining Techniques: Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, KNN Algorithm.

UNIT - IV

Cluster detection, K- means Algorithm, Outlier Analysis, memory-based reasoning, link analysis, Mining Association Rules in Large Databases: Association Rule Mining, genetic algorithms, neural networks.
Data mining tools.

Textbook(s):

1. Paul Raj Poonia, “Fundamentals of Data Warehousing”, John Wiley & Sons, 2004
2. Kamber and Han, “Data Mining Concepts and Techniques”, Hart Court India P. Ltd. Elsevier, 2nd Ed, 2001

References:

1. W. H. Inmon, “Building the operational data store”, 2nd Ed., John Wiley, 1999.
2. Pang- Ning Tan, Michael Steinbach, Viach, Vipin Kumar, Introduction to Data Mining, Pearson
3. Shmueli, “Data Mining for Business Intelligence : Concepts, Techniques and Applications in Microsoft Excel with XLMiner”, Wiley Publications

Data Warehousing and Data Mining Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/CST	7	PCE	PCE-5	CIE-425P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Data Warehousing and Data Mining) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Study of ETL process and its tools.
2. Program of Data warehouse cleansing to input names from users (inconsistent) and format them.
3. Program of Data warehouse cleansing to remove redundancy in data.
4. Introduction to WEKA tool.
5. Implementation of Classification technique on ARFF files using WEKA.
6. Implementation of Clustering technique on ARFF files using WEKA.
7. Implementation of Association Rule technique on ARFF files using WEKA.
8. Implementation of Visualization technique on ARFF files using WEKA.
9. Perform Data Similarity Measure (Euclidean, Manhattan Distance).
10. Perform Apriori algorithm to mine frequent item-sets.
11. Develop different clustering algorithms like K-Means, KMedoids Algorithm, Partitioning Algorithm and Hierarchical
12. Apply Validity Measures to evaluate the quality of Data

Distributed Systems and Cloud Computing	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/IT/CST/ITE	7	PCE	PCE-4	CIE-407T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	This course provides an insight into Distributed systems.
2.	The course Discusses important paradigms in distributed systems
3.	The course helps the students to understand process synchronization
4.	The course tells about basics of cloud computing and cloud migration

Course Outcomes (CO)

CO 1	Select appropriate distributed system and inter process communication method
CO 2	Understand various process synchronization problems in distributed systems
CO 3	Create distributed file systems using Hadoop
CO 4	Choose appropriate cloud migration approach for the organization

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	2	2	3	-	1	-	-		1		-	1
CO 2	3	3	3	3	1	-	-		1	-	-	1
CO 3	2	-	3	2	3	-	-	-	1	-	-	1
CO 4	2	2	-	-	-	2	2	-	-	-	-	2

UNIT-I

Introduction to Distributed Systems: Characteristics of Distributed Systems-Introduction, Examples of Distributed systems (Client server, peer to peer, grid and cloud computing), Advantages of distributed systems, System models -Introduction, Architectural and Fundamental models, Networking and Internetworking, Interposes Communication (message passing and shared memory), Distributed objects and Remote Method Invocation, RPC, Events and notifications, Case study-Java RMI.

UNIT-II

Synchronization: Time and Global States-Introduction, Logical Clocks, Synchronizing physical clocks events and Process states, Synchronizing physical clocks, logical time and logical clocks, global states, distributed debugging, Coordination and Agreement: Distributed mutual exclusion, Elections, Multicast communication, consensus and related problems.

UNIT-III

Distributed File Systems: Introduction – File Models – File accessing, sharing and caching – File Replication – Atomic transactions Case Study HADOOP. : Resource and process management – Task assignment approach – Load balancing approach – Load sharing approach

UNIT – IV

Cloud Computing, Roots of Cloud Computing, Layers and Types of Clouds, Desired Features of a Cloud, Cloud Infrastructure Management, Infrastructure as a Service, Hardware as a service, platform as a Service, Software as a service, Challenges and Risks. Migrating into a Cloud:-Introduction, Broad Approaches to Migrating into the Cloud, The Seven-Step Model of Migration into a Cloud

Textbook(s):

1. Distributed Systems Concepts and Design, G Coulouris, J Dollimore and T Kindberg, Fourth Edition, Pearson
2. R. Buyya, CLOUD COMPUTING Principles and Paradigms, Willey
3. Distributed Systems, S.Ghosh, Chapman & Hall/CRC, Taylor & Francis Group, 2010.

References:

1. Distributed Systems – Principles and Paradigms, A.S. Tanenbaum and M.V. Steen, Pearson Education.
2. Distributed Computing, Principles, Algorithms and Systems, Ajay D. Kshemakalyani and Mukesh Singhal, Cambridge, rp 2010.
3. Gerard Tel, “Introduction to Distributed algorithms”, Cambridge University Press, USA, 2000.

Distributed Systems and Cloud Computing Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE/IT/CST/ITE	7	PCE	PCE-4	CIE-407P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Distributed Systems and Cloud Computing) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Write a Program in Java to implement RPC
2. Implement the concept of Remote Method Invocation in Java.
3. Write a java program to implement Lamport's Logical clock
4. Implement mutual exclusion service using Lamport's Mutual Exclusion Algorithm
5. Install Hadoop on Windows
6. Run a simple application on single node Hadoop Cluster
7. Install Google App Engine and develop a simple web application.
8. Launch Web application using Google App Engine
9. Install Virtualbox / VMware Workstation with different flavours of linux on windows.
10. Simulate a cloud scenario using CloudSim and run a scheduling algorithm

Machine Learning	**L**	**P**	**C**
	3		**3**

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ECE	6	PCE	PCE-3	ECE-350T
EAE	6	MLDA-EAE	MLDA-EAE-2C	ML-342T
CSE/IT/CST/ITE	7	PCE	PCE-5	CIE-421T
CSE-AIML	7	PC	PC	ML-407T
EAE	7	AIML-EAE	AIML-EAE-3	ML-407T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the need of machine learning
2.	To learn about regression and feature selection
3.	To understand about classification algorithms
4.	To learn clustering algorithms

Course Outcomes (CO)

CO 1	To formulate machine learning problems
CO 2	Learn about regression and feature selection techniques
CO 3	Apply machine learning techniques such as classification to practical applications
CO 4	Apply clustering algorithms

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	3	2	2	-	-	-	-	2
CO 2	3	3	3	3	3	2	2	-	-	-	-	2
CO 3	3	3	3	3	3	2	2	-	-	-	-	2
CO 4	3	3	3	3	3	2	2	-	-	-	-	2

UNIT-I

Introduction: Machine learning, terminologies in machine learning, Perspectives and issues in machine learning, application of Machine learning, Types of machine learning: supervised, unsupervised, semi-supervised learning. Review of probability, Basic Linear Algebra in Machine Learning Techniques, Dataset and its types,Data preprocessing, Bias and Variance in Machine learning , Function approximation, Overfitting

UNIT-II

Regression Analysis in Machine Learning: Introduction to regression and its terminologies,Types of regression,Logistic Regression

Simple Linear regression: Introduction to Simple Linear Regression and its assumption, Simple Linear Regression Model Building,Ordinary Least square estimation, Properties of the least-squares estimators and the fitted regression model, Interval estimation in simple linear regression , Residuals
Multiple Linear Regression:Multiple linear regression model and its assumption, **Interpret Multiple Linear Regression Output(R-Square, Standard error, F, Significance F, Cofficient P values), Access the fit of multiple linear regression model (**R squared, Standard error)
Feature Selection and Dimensionality Reduction: PCA, LDA, ICA

UNIT-III

Introduction to Classification and Classification Algorithms: What is Classification? General Approach to Classification, k-Nearest Neighbor Algorithm, Random Forests, Fuzzy Set Approaches
Support Vector Machine: Introduction, Types of support vector kernel – (Linear kernel, polynomial kernel, and Gaussiankernel), Hyperplane – (Decision surface), Properties of SVM, and Issues in SVM.
Decision Trees: Decision tree learning algorithm,ID-3algorithm, Inductive bias, Entropy and information theory, Information gain,Issues in Decision tree learning.
Bayesian Learning - Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm
Ensemble Methods: Bagging, Boosting and AdaBoost and XBoost,
Classification Model Evaluation and Selection: Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, Lift Curves and Gain Curves, ROC Curves, Misclassification Cost Adjustment to Reflect Real-World Concerns, Decision Cost/Benefit Analysis

UNIT – IV

Introduction to Cluster Analysis and Clustering Methods: The Clustering Task and the Requirements for Cluster Analysis , Overview of Some Basic Clustering Methods:-k-Means Clustering, k-Medoids Clustering, Density-Based Clustering: DBSCAN - Density-Based Clustering Based on Connected Regions with High Density, Gaussian Mixture Model algorithm , Balance Iterative Reducing and Clustering using Hierarchies (BIRCH) , Affinity Propagation clustering algorithm,Mean-Shift clustering algorithm, ordering Points to Identify the Clustering Structure (OPTICS) algorithm, Agglomerative Hierarchy clustering algorithm, **Divisive Hierarchical** , Measuring Clustering Goodness

Textbook(s):

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (India) Private Limited, 2013.
2. M. Gopal, “Applied Machine Learning”, McGraw Hill Education

References:
1. C. M. BISHOP (2006), “Pattern Recognition and Machine Learning”, Springer-Verlag New York, 1st Edition
2. R. O. Duda, P. E. Hart, D. G. Stork (2000), Pattern Classification, Wiley-Blackwell, 2nd Edition

Machine Learning Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ECE	6	PCE	PCE-3	ECE-350P
EAE	6	MLDA-EAE	MLDA-EAE-2C	ML-342P
CSE/IT/CST/ITE	7	PCE	PCE-5	CIE-421P
CSE-AIML	7	PC	PC	ML-407P
EAE	7	AIML-EAE	AIML-EAE-3	ML-407P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Machine Learning) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Introduction to JUPYTER IDE and its libraries Pandas and NumPy
2. Program to demonstrate Simple Linear Regression
3. Program to demonstrate Logistic Regression
4. Program to demonstrate Decision Tree – ID3 Algorithm
5. Program to demonstrate k-Nearest Neighbor flowers classification
6. Program to demonstrate Naïve- Bayes Classifier
7. Program to demonstrate PCA and LDA on Iris dataset
8. Program to demonstrate DBSCAN clustering algorithm
9. Program to demonstrate K-Medoid clustering algorithm
10. Program to demonstrate K-Means Clustering Algorithm on Handwritten Dataset

Machine Learning and Data Analytics Case Studies	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	MLDA-EAE	MLDA-EAE-5A	ML-467T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	This course provides the fundamental concepts in data science.
2.	Learn the Basics of statistical data analysis with examples.
3.	Basics of Machine Learning and statistical measures.
4.	Compile and visualize data using statistical functions.

Course Outcomes (CO)

CO 1	Impart the knowledge of data classification, process of big data technology, user roles and skills in data science.
CO 2	Understand how data is analysed and visualized using statistic functions
CO 3	Analyze the methodologies of data science
CO 4	Design the code for the problems related to data science using R

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	2	3	-	2	-	-	-	-	-	-
CO 2	-	3	-	2	-	-	-	-	-	-	2	-
CO 3	-	-	-	3	3	3	-	-	-		2	3
CO 4	-	-	3	2	-	3	-	-	-	-	2	2

UNIT-I

Unsupervised Machine Learning Algorithms: Dimensionality Reduction, Clustering, Supervised Machine Learning Problems: Regression and classification.

Case Study: Balanced Scorecard Model for Measuring Organizational Performance, Employee Attrition in an Organization, Market Capitalization Categories, Performance Appraisal in Organizations, Application of Technology Acceptance Model in Cloud Computing, Prediction of Customer Buying Intention due to Digital Marketing.

UNIT-II

Supervised Machine Learning Algorithms: Naïve Bayes Algorithm, k-Nearest Neighbor's (KNN) Algorithm, Support Vector Machines (SVMs), Decision Trees.

Case Study: Measuring Acceptability of a New Product, Case Study: Predicting Phishing Websites, Fraud Analysis for Credit Card and Mobile Payment Transactions, Artificial Intelligence and Employment.

UNIT-III

Data Analytics- Relation: Data Science, Analytics and Big Data Analytics. Data Science Components – Big data technology – Data Science user- roles and skills- Data Science use cases. Statistical Measures in R: Measures of central tendency – Range- inter quartile range – Mean – Median – variance- Standard deviation – Sampling distribution – probability distributions- hypothesis tests.

UNIT - IV

Mathematics for Data science Probability, Statistics, Linear Algebra, Gradient Descent, Calculus for data science, ANOVA, Hypothesis testing, Data Visualization using GGPLOT2 and Matplotlib, Data Pre-processing, Data Transformation, Data Reduction, Feature Extraction. Univariate and Multi-variate analysis.
Case study: Insurance policy offers, Discount targeting in online shopping.

Textbook(s):
1. Data analytics with R by Dr. Bharti Motwani , Wiley publication
2. V. Bhuvaneswari (2016). Data Analytics with R, Bharathiar University.

References:
1. Nina Zumal, John Mount (2014). Practical Data science in R, Managing Publication Company
2. Sandip Rakshit, R Programming for Beginners, McGraw Hill Education (India), 2017

Machine Learning and Data Analytics Case Studies Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	MLDA-EAE	MLDA-EAE-5A	ML-467P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Machine Learning and Data Analytics Case Studies) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

Implement a case study mentioned in syllabus by considering following methods.

1. **Define the problem statement:** Clearly articulate the problem you want to solve or the objective you want to achieve using machine learning and data analytics.
2. **Gather and preprocess data:** Collect relevant data for your case study and perform necessary preprocessing tasks such as data cleaning, handling missing values, and feature engineering.
3. **Exploratory data analysis (EDA):** Analyze the dataset to gain insights into the data distribution, identify patterns, and visualize relationships between variables.
4. **Split the data and model training:** Divide the dataset into training, validation, and testing sets and train your models on the training set, tune hyperparameters using the validation set, and evaluate their performance on the testing set.
5. **Model evaluation:** Train the selected machine learning models using the training set and evaluate their performance using appropriate metrics such as accuracy, precision, recall, F1-score, or mean squared error.
6. **Deployment:** Implement the chosen model in a real-world scenario, considering factors such as scalability, performance, and integration with existing systems.
7. **Interpretation and visualization:** Interpret the results of your models and visualize them in a meaningful way. This helps in presenting insights to stakeholders and understanding the impact of different variables on the outcome.
8. **Documentation:** Document your case study, including the problem statement, data sources, preprocessing steps, modeling techniques used, results obtained, and any limitations or assumptions made during the process.
9. **Communication and presentation:** Prepare a clear and concise presentation of your case study findings, highlighting the key insights and recommendations derived from your analysis.
10. **Ethical considerations:** Consider ethical aspects such as data privacy, bias, and fairness throughout the entire process. Ensure that your models and analyses are fair, transparent, and aligned with legal and ethical guidelines.

Pattern Recognition and Computer Vision	**L**	**P**	**C**
	3		**3**

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE-AIML	7	PC	PC	ML-411T
EAE	7	AIML-EAE	AIML-EAE-5	ML-411T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	Understand the in-depth concept of Pattern Recognition
2.	Implement Bayes Decision Theory
3.	Understand the in-depth concept of Perception and related Concepts
4.	Understand the concept of ML Pattern Classification

Course Outcomes (CO)

CO 1	Discuss various concepts of pattern recognition
CO 2	Understanding various algorithms
CO 3	Explain and apply various computer vision techniques
CO 4	Describe the concept of shape analysis and filtering

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	3	3	-	2	-	-	1	3	2
CO 2	3	3	1	1	1	-	1	1	-	2	2	1
CO 3	3	2	3	3	2	-	2	-	-	2	3	1
CO 4	1	2	3	2	2	-	1	-	-	1	2	2

UNIT-I

Induction Algorithms. Rule Induction. Decision Trees. Bayesian Methods. The Basic Naıve Bayes Classifier. Naive Bayes Induction for Numeric Attributes. Correction to the Probability Estimation. Laplace Correction. No Match. Other Bayesian Methods. Other Induction Methods. Neural Networks. Genetic Algorithms. Instance-based Learning. Support Vector Machines.

UNIT-II

About Statistical Pattern Recognition. Classification and regression. Features and Feature Vectors, and Classifiers. Pre-processing and feature extraction. The curse of dimensionality. Polynomial curve fitting. Model complexity. Multivariate non-linear functions. Bayes' theorem. Decision boundaries. Parametric methods. Sequential parameter estimation. Linear discriminant functions. Fisher's linear discriminant. Feed-forward network mappings.

UNIT-III

Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology – texture.

UNIT – IV

Binary shape analysis – connectedness – object labelling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moments.

Textbook(s):

1. Pattern Classification, Richard O. Duda, Peter E. Hart, and David G. Stork. Wiley, 2000, 2nd Edition
2. D. L. Baggio et al., Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing, 2012.

References:

1. Pattern Recognition, Jürgen Beyerer, Matthias Richter, and Matthias Nagel. 2018
2. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012

Pattern Recognition and Computer Vision Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE-AIML	7	PC	PC	ML-411P
EAE	7	AIML-EAE	AIML-EAE-5	ML-411P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Pattern Recognition and Computer Vision) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Write a MATLAB/Python function that computes the value of the Gaussian distribution N(m,s) at given vector X and plot the effect of varying mean and variance to the normal distribution.
2. Implementation of Gradient descent.
3. Implementation of Linear Regression using Gradient descent.
4. Comparison of classification accuracy of SVM and CNN for the dataset.
5. Implementation basic Image Handling and processing operations on the image.
6. Implementation of Geometric Transformation.
7. Implementation of Perspective Transformation.
8. Implementation of Camera Calibration
9. Compute Fundamental Matrix.

Principles of Entrepreneurship Mindset	L	P	C
	2		2

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
All	7	HS/MS	MS	MS-401

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand basic aspects of establishing a business in a competitive environment
2.	To apply the basic understanding to examine the existing business ventures
3.	To examine various business considerations such as marketing, financial and teaming etc.
4.	To assess strategies for planning a business venture

Course Outcomes (CO)

CO 1	Understand basic aspects of establishing a business in a competitive environment
CO 2	Apply the basic understanding to examine the existing business ventures
CO 3	Examine various business considerations such as marketing, financial and teaming etc.
CO 4	Assessing strategies for planning a business venture

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	2	2	1	2	-	2	-	-	1	2	3	2
CO 2	2	2	1	2	-	2	-	-	1	2	3	2
CO 3	2	2	1	2	-	2	-	-	1	2	3	2
CO 4	2	2	1	2	-	2	-	-	1	2	3	2

UNIT-I

Entrepreneurial perspective: Foundation, Nature and development ofentrepreneurship, importance of entrepreneurs,Entrepreneurial Mind, Individual entrepreneur Typesof entrepreneurs, Entrepreneurship in India

UNIT-II

Beginning Considerations: Creativity and developing business ideas; Creatingand starting the venture; Building a competitiveadvantage; Opportunity recognition, Opportunityassessment; Legal issues

UNIT-III

Developing Financial Plans: Sources of Funds,Managing Cash Flow,Creating a successful Financial PlanDeveloping a business plan

UNIT - IV

Developing Marketing Plans: Developing a powerful Marketing Plan, E-commerce,Integrated Marketing Communications
Leading Considerations: Developing Team, Inviting candidates to join team,Leadership model

Textbook(s):

1. Robert D Hisrich, Michael P Peters & Dean A Shepherd, "Entrepreneurship" 10th Edition,McGraw Hill Education, 2018

References:

1. Norman M. Scarborough and Jeffery R. cornwell, "Essentials of entrepreneurship and small business management" 8th Edition, Pearson, 2016
2. Rajiv Roy, "Entrepreneurship", 2nd Edition, Oxford University Press, 2011
3. Sangeeta Sharma, "Entrepreneurship Development", 1st Edition, Prentice-Hall India, 2016
4. John Mullins, "The New Business Road Test: What entrepreneurs and investors should dobefore launching a lean start-up" 5th Edition, Pearson Education, 2017
5. Charantimath, Entrepreneurship Development and Small Business Enterprise, Pearson Education.

Reinforcement Learning and Deep Learning	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE-AIML	7	PC	PC	ML-409T
EAE	7	AIML-EAE	AIML-EAE-4	ML-409T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To introduce the foundation of Reinforcement learning foundation and Q Network algorithm)
2.	To understand policy optimization ,recent advanced techniques and applications of Reinforcement learning
3.	To introduce the concept of deep learning and neural network
4.	To understand the concept of NLP and computer vision in deep learning

Course Outcomes (CO)

CO 1	Learn how to define RL tasks and the core principals behind the RL, including policies, value functions, deriving Bellman equations and underst and work with approximate solution(deep Q Network based algorithms)
CO 2	Learn the policy gradient methods from vanilla to more complex cases and learn application and advanced techniques in Reinforcement Learning
CO 3	Apply neural networks for problem solving
CO 4	Able to Analyse images and have basic understanding of NLP in deep learning

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	3	3	3	2	2	-	-	-	-	2
CO 2	3	2	3	3	3	2	2	-	-	-	-	2
CO 3	3	2	3	3	3	2	2	-	-	-	-	2
CO 4	3	2	3	3	3	2	2	-	-	-	-	2

UNIT-I

Reinforcement Learning Foundation: Introduction to Reinforcement learning and its terms,Features and elements of RL, Defining RL Framework and Markov Decision Process , Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Code Standards and Libraries used in RL (Python/Keras/Tensorflow)
Tabular Methods and Q-networks: Planning through the use of Dynamic Programming and Monte Carlo, Temporal-Difference learning methods (TD(0), SARSA, Q-Learning), Deep Q-networks (DQN, DDQN, Dueling DQN, Prioritised Experience Replay)

UNIT-II

Policy Optimization: Introduction to policy-based methods, Vanilla Policy Gradient, REINFORCE algorithm and stochastic policy search, Actor-critic methods (A2C, A3C) ,Advanced policy gradient (PPO, TRPO, DDPG),
Model-Based RL: Model-based RL approach
Recent Advances and Applications: Meta-learning. Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Applying RL for real-world problems

UNIT-III

Introduction to Deep learning: Introduction to deep learning and its application,Examples of deep learning
Introduction to Neural Network: Introduction to Neural Network its types and application,Introduction to keras,Introduction to ANN Perceptron and its uses,Multilayer perceptron and deep neural network,Activation function and its working TanH function,sigma ,relu etc ,Feed forward network, Cost function, Backpropagation, Gradient Descent, Regulariztion and dropout technique, Batch normalization.
Types of Neural Network: Convolutional Neural network,CNN Pooling,CNN Layers,Flattening and Full connection,Preparing a fully connected neural network,Introduction to RNN, Deep RNN, Long Short Term Memory, GRU, Transfer Learning,

UNIT – IV

Deep Learning for Natural Language Processing: Introduction to NLP and Vector Space Model of Semantics Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning
Deep Learning for Computer Vision: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks.

Textbook(s):
1.Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", 2nd Edition, MIT Press, 2019
2. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep learning." MIT press, 2016.
3. Antonio Gulli and Sujit Pal,"Deep learning with Keras"

References:
1. Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning: Adaptation, Learning, and Optimization" (2012)
2. Daniel Slater, Gianmario Spacagna and Peter Roelants, "Python Deep Learning", Packt Publication.

Reinforcement Learning and Deep Learning Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
CSE-AIML	7	PC	PC	ML-409P
EAE	7	AIML-EAE	AIML-EAE-4	ML-409P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Reinforcement Learning and Deep Learning) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Setting up the Spyder IDE Environment and Executing a Python Program
2. Installing Keras, Tensorflow and Pytorch libraries and making use of them
3. Implement Q-learning with pure Python to play a game
   - Environment set up and intro to OpenAI Gym
   - Write Q-learning algorithm and train agent to play game
   - Watch trained agent play game
4. Implement deep Q-network with PyTorch
5. Python implementation of the iterative policy evaluation and update.
6. Chatbot using bi-directional LSTMs
7. Image classification on MNIST dataset (CNN model with fully connected layer)
8. Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU
9. Applying the Deep Learning Models in the field of Natural Language Processing
10. Applying the Convolution Neural Network on computer vision problems

Supervised and Deep Learning	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	MLDA-EAE	MLDA-EAE-3	ML-463T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To introduce students to the fundamentals of Supervised Learning and Deep Learning techniques and algorithms.
2.	To enable students to develop skills in implementing supervised and deep learning algorithms using Python programming language and popular machine learning libraries.
3.	To equip students with the ability to evaluate the performance of supervised and deep learning models and select the appropriate models for specific problems.
4.	To provide students with hands-on experience in working with real-world supervised and deep learning projects.

Course Outcomes (CO)

CO 1	Develop a deep understanding of the concepts and applications of Supervised Learning and Deep Learning techniques and algorithms.
CO 2	Develop proficiency in using Python programming language and popular machine learning libraries to implement supervised and deep learning models.
CO 3	Demonstrate the ability to evaluate the performance of supervised and deep learning models and select the appropriate models for specific problems.
CO 4	Gain hands-on experience in working with real-world supervised and deep learning projects, including image recognition, text analysis, and time-series analysis.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	3	-	-	-	3	2	2	3
CO 2	3	2	2	2	3	-	-	-	3	2	2	3
CO 3	3	2	2	2	3	-	-	-	3	2	2	3
CO 4	3	2	2	2	3	-	-	-	3	2	2	3

UNIT-I

Introduction to Machine Learning, Types of Machine Learning, Supervised Learning Basics, Regression and Classification, Linear Regression, Logistic Regression, Model Evaluation Metrics

UNIT-II

Introduction to Deep Learning, Artificial Neural Networks, Activation Functions, Loss Functions, Optimization Algorithms, Backpropagation Algorithm, Regularization Techniques

UNIT-III

Introduction to CNNs, CNN Architecture, Convolution and Pooling Layers, Object Detection, Image Segmentation, Transfer Learning, Introduction to RNNs, RNN Architecture, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Text Generation, Language Translation

UNIT – IV

Generative Adversarial Networks (GANs), Autoencoders, Reinforcement Learning, Natural Language Processing (NLP), Sentiment Analysis, Time Series Analysis

Textbooks:

1. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", 2nd Edition, O'Reilly Media, 2019. ISBN: 978-1492032649
2. Francois Chollet, "Deep Learning with Python", 1st Edition, Manning Publications, 2017. ISBN: 978-1617294433

Reference Books:

1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron.
2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
3. "Pattern Recognition and Machine Learning" by Christopher M. Bishop.
4. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016. ISBN: 978-0262035613
5. Andrew Ng, "Machine Learning Yearning", eBook, 2018.
6. Sebastian Raschka and Vahid Mirjalili, "Python Machine Learning", 3rd Edition, Packt Publishing, 2019. ISBN: 978-1789955750

Supervised and Deep Learning Lab	L	P	C
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Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	MLDA-EAE	MLDA-EAE-3	ML-463P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Supervised and Deep Learning) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Linear regression: Implement linear regression on a dataset and evaluate the model's performance.
2. Logistic regression: Implement logistic regression on a binary classification dataset and evaluate the model's performance.
3. k-Nearest Neighbors (k-NN): Implement k-NN algorithm on a dataset and evaluate the model's performance.
4. Decision Trees: Implement decision trees on a dataset and evaluate the model's performance.
5. Random Forest: Implement random forest algorithm on a dataset and evaluate the model's performance.
6. Support Vector Machines (SVM): Implement SVM on a dataset and evaluate the model's performance.
7. Naive Bayes: Implement Naive Bayes algorithm on a dataset and evaluate the model's performance.
8. Gradient Boosting: Implement gradient boosting algorithm on a dataset and evaluate the model's performance.
9. Convolutional Neural Networks (CNN): Implement CNN on an image classification dataset and evaluate the model's performance.
10. Recurrent Neural Networks (RNN): Implement RNN on a text classification dataset and evaluate the model's performance.
11. Long Short-Term Memory Networks (LSTM): Implement LSTM on a time-series dataset and evaluate the model's performance.
12. Autoencoders: Implement autoencoders on an image dataset and evaluate the model's performance.
13. Generative Adversarial Networks (GANs): Implement GANs on an image dataset and evaluate the model's performance.
14. Transfer Learning: Implement transfer learning on an image dataset and evaluate the model's performance.
15. Reinforcement Learning: Implement reinforcement learning on a game environment and evaluate the model's performance.

Unsupervised Learning	L	P	C
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Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	MLDA-EAE	MLDA-EAE-4	ML-465T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To learn about unsupervised learning and clustering algorithms
2.	To learn about Gaussian mixture models and linear dimensional reduction methods
3.	To learn about autoencoders and generative adversarial network
4.	To learn about outlier detection,density estimation methods and unsupervised learning networks

Course Outcomes (CO)

CO 1	Applying clustering algorithms for the real world data
CO 2	Applying Dimensional reduction techniques for feature extraction and learn,Gaussian mixture models
CO 3	Learn about Autoencoders and Genearative adversarial network
CO 4	Applying outlier and novelity detection,density estimation methods to real world data and learn about unsupervised learning networks

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	3	3	3	2	2	-	-	-	-	2
CO 2	3	2	3	3	3	2	2	-	-	-	-	2
CO 3	3	2	3	3	3	2	2	-	-	-	-	2
CO 4	3	2	3	3	3	2	2	-	-	-	-	2

UNIT-I

Unsupervised learning - Introduction, Unsupervised vs Supervised Learning, Application of Unsupervised Learning,

Clustering –Clustering as a Machine Learning task, Different types of clustering techniques, Partitioning methods, Hierarchical clustering, Density-based methods: DBSCAN

Biclustering :Spectral co-clustering,spectral biclustering

Finding Pattern using Association Rule - Definition of common terms, Association rule, Apriori algorithm.

UNIT-II

Gaussain Mixture Models: Gaussian mixture ,Variational Bayesian Gaussian mixture

Manifold learning:Introduction,Isomap,Locally linear embedding,Modified locally linear embedding,Spectral embedding,MDS(Multi dimensional scaling, t-distributed Stochastic Neighbor Embedding (t-SNE)

Decomposing signals in components (matrix factorization problems):PCA(Principal component Anlysis),Factor Analysis, Kernel Principal Component Analysis (kPCA), Truncated singular value decomposition and latent semantic analysis, Independent component analysis (ICA), Non-negative matrix factorization (NMF or NNMF), Latent Dirichlet Allocation (LDA)

UNIT-III

Autoencoders: Architecture,Layers in autoencoder ,training of autoencoder ,Sparse Coding, Undercomplete Autoencoders, Regularized Autoencoders, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders.
Generative Adversarial Networks: Generative Vs Discriminative Modeling, Probabilistic Generative Model, Generative Adversarial Networks (GAN), GAN challenges: Oscillation Loss, Mode Collapse, Uninformative Loss, Hyperparameters, Tackling GAN challenges, Wasserstein GAN, Cycle GAN, Neural Style Transfer

UNIT - IV

Novelty and outlier detection:Overview of outlier detection methods,Novelty detection,outlier detection
Density estimation:Histograms and kernel density estimation
Unsupervised Learning Networks: Kohonen Self-Organizing Feature Maps – architecture, training algorithm, Kohonen Self-Organizing Motor Map,Restricted Boltzmann machine(neural network model)

Textbook(s):
1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (India) Private Limited, 2013.
2. Benyamin Ghojogh, Mark Crowley, Fakhri Karray, ¸ Ali Ghodsi , Elements of Dimensionality Reduction and Manifold Learning,Springer

References:
1. C. M. BISHOP (2006), "Pattern Recognition and Machine Learning", Springer-Verlag New York, 1st Edition
2. Kevin Murphy, *Machine learning: a probabilistic perspective*.
3. Jennifer Grange ," Machine Learning for Absolute Beginners: A Simple, Concise & Complete Introduction to Supervised and Unsupervised Learning Algorithms",Kindle

Unsupervised Learning Lab	L	P	C
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Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	MLDA-EAE	MLDA-EAE-4	ML-465P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Unsupervised Learning) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Setting up the Jupyter Notebook and Executing a Python Program
2. Installing Keras, Tensorflow and Pytorch,Pandas ,numpy etc libraries and making use of them
3. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
4. Program to demonstrate k-means clustering algorithm
5. Program to demonstrate DBSCAN clustering algorithm
6. Program to demonstrate PCA and LDA on Iris dataset
7. Compare the performance of PCA and Autoencoders on a given dataset
8. Build Generative adversarial model for fake (news/image/audio/video) prediction.
9. Outlier detection in time series dataset using RNN
10. Anomaly detection using Self-Organizing Network