Seventh Semester (Emerging Area Specialization: Artificial Intelligence and Machine Learning)

Group	Paper Code	Paper	L	P	Credits
Theory Papers					
HS/MS	MS-401	Principles of Entrepreneurship Mindset	2	-	2
PCE 4	EEE-407	Renewable Energy and Policies	4	-	4
PCE 5	EEE-423	Energy Conservation Schemes	4	.	4
AIML-EAE-3	ML-407T	Machine Learning	3	-	3
AIML-EAE-4	ML-409T	Reinforcement Learning and Deep Learning	3	-	3
AIML-EAE-5	ML-411T	Pattern Recognition and Computer Vision	3	-	3
Practical / Viva Voce					
PC / Project	ES-451	Minor Project**	-	-	3
PC / Internship	ES-453	Summer Training Report - 2 *	-	-	1
AIML-EAE-3	ML-407P	Machine Learning Lab	-	2	1
AIML-EAE-4	ML-409P	Reinforcement Learning and Deep Learning Lab	-	2	1
AIML-EAE-5	ML-411P	Pattern Recognition and Computer Vision Lab	-	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.**

Note : Following Programme Core Elective Paper (PCE) and Emerging Area/Open Area Elective Paper (EAE/OAE) has been selected by students in Fifth semester

Seventh Semester(Emerging Area Specialization: Electrical Vehicles)

Group	Paper Code	Paper	L	P	Credits
Theory Papers					
HS/MS	MS-401	Principles of Entrepreneurship Mindset	2	-	2
PCE 4	EEE-407	Renewable Energy and Policies	4	-	4
PCE 5	EEE-423	Energy Conservation Schemes	4	.	4
EV-EAE-3	EV-413T	EV Charging Infrastructure Technology	3	-	3
EV-EAE-4	EV-415	Economics and Policies of e-Mobility	4	-	4
EV-EAE-5	EV-417T	Embedded Systems for Electric Vehicles	3	-	3
Practical / Viva Voce					
PC / Project	ES-451	Minor Project**	-	-	3
PC / Internship	ES-453	Summer Training Report - 2 *	-	-	1
EV-EAE-3	EV-413P	EV Charging Infrastructure Technology Lab	-	2	1
EV-EAE-5	EV-417P	Embedded Systems for Electric Vehicles Lab	-	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.**

Note : Following Programme Core Elective Paper (PCE) and Emerging Area/Open Area Elective Paper (EAE/OAE) has been selected by students in Fifth semester

Economics and Policies of e-Mobility	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	EV-EAE	EV-EAE-4	EV-415

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 impart the knowledge of Indian and global scenario of E- Mobility.
2.	To impart the knowledge of Dynamics testing of Vehicles.
3.	To impart the knowledge of vehicle component testing.
4.	To impart the knowledge of the static testing of vehicles.

Course Outcomes (CO)

CO 1	To understand the Indian and global scenario of E- Mobility.
CO 2	To provide the knowledge of Dynamics testing of Vehicles.
CO 3	To understand the vehicle component testing
CO 4	To analyze and understand the knowledge of the static testing of vehicles.

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	2	1	1	-	2	1	-	2
CO 2	3	3	3	3	2	1	1	-	2	1	-	2
CO 3	3	3	3	3	2	1	1	-	2	1	-	2
CO 4	3	3	3	3	2	1	1	-	2	1	-	2

UNIT I

Indian and Global Scenario: Technology Scenario - Market Scenario - Policies and Regulations - Payback and commercial model - Polices in India – opportunities

Introduction: Specification & Classification of Vehicles (including M, N and O layout) - Homologation & its Types - Regulations overview (EEC, ECE, FMVSS, AIS, CMVR) - Type approval Scheme.

UNIT II

Dynamics Testing of Vehicle: Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broadband / Narrowband EMI Test, Electric vehicle, RangeTest.

UNIT III

Vehicle Component Testing: Horn Testing - Safety Glasses Test - Windscreen laminated and toughened safety glass - Rear View Mirror Test - Hydraulic Brakes Hoses Fuel Tank Test - Metallic & Plastic - Hinges and Latches

Test, Tyre & Wheel Rim Test - Bumper Impact Test - Side Door Intrusion - Crash test with dummies - Demist test - Defrost Test.

UNIT IV

STATIC TESTING OF VEHICLE: CMVR physical verification - Tyre Tread Depth Test - Vehicle Weightment - Horn installation - Rear view mirror installation - External Projection - tell-tale - Wheel Guard - Arrangement of Foot Controls for M1 Vehicle - Angle & Dimensions Measurement of Vehicle - The Requirement of Temporary Cabin For Drive away - Chassis.

Textbook(s):

1. "Vehicle Inspection Handbook", Indian Association of Motor Vehicle Administrators

References:

1. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI PUNE
2. Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007

Embedded Systems for Electric Vehicles	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	EV-EAE	EV-EAE-5	EV-417T

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 impart the knowledge of automotive fundamentals.
2.	To impart the knowledge of vehicle management system.
3.	To impart the knowledge of vehicle automotive telematics.
4.	To impart the knowledge of electronic diagnostics of vehicles.

Course Outcomes (CO)

CO 1	To understand the basics of automotive fundamentals.
CO 2	To understand the vehicle management system.
CO 3	To understand the vehicle automotive telematics.
CO 4	To understand system diagnostic standard and regulation requirement.

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	2	1	1	-	2	1	-	2
CO 2	3	3	3	3	2	1	1	-	2	1	-	2
CO 3	3	3	3	3	2	1	1	-	2	1	-	2
CO 4	3	3	3	3	2	1	1	-	2	1	-	2

UNIT I

Automotive Fundamentals: Automotive physical configuration, drive train, suspension, brakes, steering system. Systemsapproach to control and instrumentation: Characteristics of digital electronic system, Instruments, Control system. Vehicle motion control: Cruise control system, Antilock brakingsystem, Electronic suspension system, Electronic steering control, automotive instrumentation,on board and off – board diagnostics, occupant protection systems.

UNIT II

Vehicle Management Systems: Vehicle cruise control- speed control anti-locking braking system-electronic suspension - electronic steering, wiper control; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- for sensors, accelerators, brake Battery management, Electric Vehicles-Electrical loads, power management system-electrically assisted power steering system

UNIT III

Automotive Telematics: Role of Bluetooth, CAN, LIN and flex ray communication protocols in automotive applications; Multiplexed vehicle system architecture for signal and data / parameter exchange between EMS, ECUs with other vehicle system components and other control systems; Realizing bus interfaces for diagnostics, dashboard display, multimedia electronics.

UNIT IV

Electronic Diagnostics For Vehicles: System diagnostic standards and regulation requirements – On board diagnosis of vehicles electronic units & electric units-Speedometer, oil and temperature gauges, and audio system.

Textbook(s):

1. William B. Ribbens,"Understanding Automotive Electronics", Elseiver,2012
2. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, AirAnd Space Vehicles" Marcel Decker, 2004.
3. L.Vlacic, M.Parent, F.Harahima,"Intelligent Vehicle Technologies", SAE International, 2001.
4. Jack Erjavec,Jeff Arias,"Alternate Fuel Technology-Electric ,Hybrid & FuelCellVehicles",Cengage ,2012

References:

1. Tom Denton, "Automotive Electricals / Electronics System and Components", 3rd Edition, 2004.
2. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, andVehicle", Springer; 1st edition, March 30, 2000.
3. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4th Edition, 2004.

Embedded Systems for Electric Vehicles Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	EV-EAE	EV-EAE-5	EV-417P

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 (Embedded Systems for Electric Vehicles) 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. Program to toggle all the bits of port P1 continuously with 250 ms delay.
2. Program to interface a switch and a buzzer to two different pins of a port such that the buzzer
3. Program to interface LCD data pins to port P1 and display a message on it
4. Program to interface seven segment display using 89V51RD2
5. Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD.
6. Program to transmit message from microcontroller to PC serially using RS232 and Program to receive a message from PC to microcontroller serially using RS232.
7. Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise Directions.
8. Program to read data from temperature sensor and display the temperature value.
9. Port RTOS on to 89V51 Microcontroller and verify. Run 2 to 3 tasks simultaneously on 89V51 SDK. Use LCD interface, LED interface, Serial communication.
10. Program to convert analog signal into digital (ADC).
11. Program to convert Digital into Analog (DAC).

Energy Conservation Schemes	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	7	PCE	PCE-5	EEE-423

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 Develop a strategic direction for organizations involved with energy and power
2.	To Understand the role of energy management and energy Auditing.
3.	To Understand the various types of theft in Electro-mechanical & Electronics meters
4.	To Understand Energy Conservation in Green Building

Course Outcomes (CO)

CO 1	Develop a strategic direction for organizations involved with energy and power
CO 2	Understand the role of energy management and energy Auditing.
CO 3	Understand the various types of theft in Electro-mechanical & Electronics meters
CO 4	Understand Energy Conservation in Green Building

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	-	-	-	2	-	-	2	1
CO 2	3	2	2	2	-	-	-	2	-	-	2	1
CO 3	3	2	2	2	-	-	-	2	-	-	2	2
CO 4	3	2	2	2	-	-	-	2	-	-	2	2

UNIT I

Energy Conservation and Energy Policies: Energy policies of India and their development, Central and estate Policies on the consumption and wastage of energy, need of renewable energy in India, Energy efficiency, Energy accounting, monitoring and control, Electricity audit and related instruments, Energy consumption models, Specific Energy Consumption, Eco assessment and Evaluation methods, Energy conservation schemes, Investment in energy saving equipments, subsidies and tax rebates, Development of Energy Management System.

UNIT II

Energy Conservation in Electrical Installations: Electric loads of air conditioning and refrigeration, Energy conservation, Power consumption in compressors, Energy conservation measures, Electrolytic process, Electric heating, Furnace operation and scheduling, Transformer loading, Efficiency analysis, Feeder loss evaluation, Reactive Power, Power factor and its improvement, Capacitor sizing, Capacitor losses, location, placement and maintenance, Case studies.

UNIT III

Energy Efficient Motors: Types and operating characteristics of electric motors, Energy efficient control and starting – Load matching, Selection of motors, Efficiency and load analysis, Energy efficiency, High efficiency motors, Industrial drives, Control schemes, Variable speed drives and Energy conservation schemes, Pumps and fans, Efficient control strategies, Over-sizing Case studies.

UNIT IV

Energy Efficient Building / Green Building: Energy Conservation in Buildings Air conditioning, monitoring and control systems of energy efficient buildings. Principle of Energy efficient building design water heading system, photovoltaic systems and Energy conservation in lighting schemes, Energy efficient light sources, Domestic, commercial and industrial lighting, Lighting controls, Luminaries.

Textbooks:-

1. H. Partab, "Art and Science of Utilisation of Electrical Energy", BBES, 1970.
2. S.C. Tripathy, " Electric Energy Utilization and Conservation", Tata McGraw Hill, 1991

References:

1. Bureau of Energy efficiency of India.
2. IEEE Bronze Book: IEEE Standard 739-1984 – Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities, IEEE Publications, 1996.
3. Albent & Steve Doty Thumann: Plant Engineers and Managers Guide to Energy conservation, 10e, River Publications, 2002.
4. W.C. Turner, Energy Management Handbook, 8e, Fairmont press, 2012.
5. UNESCAP – Guide Book on Promotion of Sustainable Energy Consumption.

EV Charging Infrastructure Technology	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	EV-EAE	EV-EAE-3	EV-413T

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 impart the basics of energy storage system and charging technologies.
2.	To impart the knowledge different types of EV chargers.
3.	To impart the knowledge EVSE Power Module selection and technical specification.
4.	To impart the knowledge of EV Charging Infrastructure.

Course Outcomes (CO)

CO 1	To understand the different charging technologies.
CO 2	To understand the different types of chargers.
CO 3	Understand the EVSE modules and their selection.
CO 4	To understand EV charging infrastructure's principle, objective, and selection.

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	2	1	1	-	2	1	-	2
CO 2	3	3	3	3	2	1	1	-	2	1	-	2
CO 3	3	3	3	3	2	1	1	-	2	1	-	2
CO 4	3	3	3	3	2	1	1	-	2	1	-	2

UNIT I

Introduction: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles - Battery based energy storage - Fuel Cell based energy storage - Super Capacitor based energy storage - Fly wheel based energy storage.

Charging Methods: Electric Vehicle Technology and Charging Equipment's, Basic charging Block Diagram of Charger, Difference between Slow charger and fast charger, Slow charger design rating, Fast charger design rating

UNIT II

Types of Chargers: AC charging and DC charging - On board and off board charger specification - Type of Mode of charger Mode 2, Mode 3 and Mode 4 - Electric vehicle supply equipment (EVSE) associated charging time calculation - Selection and sizing of fast and slow charger (AC & DC) - AC Pile Charger, DC Pile Charger.

UNIT III

EVSE Power Module Selection and Technical Specification - Selection of EVSE Communication Protocol (PLC / Ethernet / Modbus/ CAN Module) - Communication gateway - Specification of open charge point protocol (OCCP 1.6/2.0) - Bharat DC001 & AC001 Charger specification - Communication Interface between charger and CMS (Central Management System) – Payment apps.

UNIT IV

The EV Charging Infrastructure (EVCI): The critical role of EVCI to enable massive EV adoption; interdependence and interactions of EVCI with existing infrastructures; principal objectives in the establishment of EVCI; role of renewable and storage resources and their effective integration; location, planning and implementation of EVCI stations; current EV charging providers and their business models; identified gaps and major challenges; policy and regulatory aspects

Textbook(s):

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010.
2. Dr.Yogini Dilip Borole, DR. V. Shanmugasundram, 'Electric Vehicle Adoption to Revolutionize Automobile Sector', IIP press, 2021.

References:

1. Michael Plint& Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd ed, 2007

EV Charging Infrastructure Technology Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	EV-EAE	EV-EAE-3	EV-413P

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 (EV Charging Infrastructure Technology) 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. To create a basic Electric Vehicle model using MATLAB/Simulink- Powertrain Blocksets
2. To create a basic Electric Vehicle model using MATLAB/Simulink- Driver Controller
3. To create a basic Electric Vehicle model using MATLAB/Simulink- Power Converter
4. To create a basic Electric Vehicle model using MATLAB/Simulink- Vehicle body
5. To create a basic Electric Vehicle model using MATLAB/Simulink- SOC (Stage of Charge)
6. To create a basic Electric Vehicle model using MATLAB/Simulink- Output circuit
7. To create complete Electric vehicle model and perform simulation various drive cycles.
8. To Model batteries and develop battery management systems (BMS).
9. To Model traction motors and develop Motor Control Units (MCU).
10. To Model fuel cell systems (FCS) and develop fuel cell control systems (FCCS)
11. Induction Motor Mathematical Modelling In MATLAB Simulink
12. Passive Cell Balancing Of Three Lithium-ion Cells For Electric Vehicle Projects
13. Capacitor Based Active Cell Balancing Of Four(4) Lithium-Ion Cells

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

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

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. Overview. Naïve Bayes. 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, 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

Renewable Energy and Policies	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	7	PCE	PCE-4	EEE-407

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 explain the concept of solar energy.
2.	To analyse wind and small hydro energy.
3.	To understand non-conventional energy resources.
4.	To analyse the importance of grid connectivity.

Course Outcomes (CO)

CO 1	Determine the need of solar energy and its applications.
CO 2	Utilise the technology for harnessing the wind and small hydro power energy
CO 3	Compare other known conventional energy sources biomas geothermal
CO 4	Discuss the importance of grid connectivity and in providing continuous power

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	1	-	-	1	3	-	-	-	-	3
CO 2	3	3	2	-	-	2	3	-	-	-	-	3
CO 3	3	-	-	-	-	-	3	-	-	-	-	1
CO 4	3	-	-	-	-	-	-	-	-	-	-	1

UNIT- I

Solar Energy: radiation – extra terrestrial, spectral distribution, solar constant, solar radiation on earth, measurements; solar thermal system – solar thermal power and its conversion, solar collectors, flat plate, solar concentrating collectors, - types and applications; photovoltaic(PV) technology - photovoltaic effect, efficiency of solar cells, semi-conductor materials, solar PV system, standards and applications, tracking.

UNIT- II

Wind and Small Hydropower Energy: wind data, properties, speed and power relation, power extracted, wind distribution and speed prediction, wind map of India; wind turbines and electric generators. fundamentals – types of machines and their characteristics, horizontal and vertical wind mills, elementary design principle, wind energy farms, off-shore plants; small, mini and micro hydro power plants and their resource assessment, plant layout with major components shown.

UNIT- III

Other Non-conventional Energy Sources: biomass – photosynthesis and origin of biomass energy, resources, cultivated resources, waste to biomass, terms and definitions – incineration, wood and wood waste, harvesting super tree, energy forest, phyrolysis, thermo-chemical biomass conversion to energy, gasification, anaerobic digester, fermentation, gaseous fuel; geothermal – resources, hot spring, steam system, principle of working, site selection, associated problems in development; ocean and tidal energy – principle of ocean thermal energy conversion, wave energy conversion machines, problems and limitations, fundamentals of tidal power, conversion systems and limitations; hydrogen energy – properties of hydrogen, sources, production and storage, transportation, problems for use as fuel; fuel cells – introduction with types, principle of operation and advantages.

UNIT-IV

Grid Connectivity: wind power interconnection requirement - low-voltage ride through (LVRT), ramp-rate limitations, supply of ancillary services for frequency and voltage control, load following, reserve requirement, impact of connection on stead-state and dynamic performance of power system; interfacing dispersed generation of solar energy with the grid, protective relaying, islanding, voltage flicker and other power quality issues; role of non-conventional energy system in smart grid.

Textbooks:

1. Tiwari and Ghosal, “Renewable Energy Resources: Basic Principle & Application”, NarosaPub.
2. S N Bhadra ,D, Kastha,’Wind Electrical Systems” Oxford Publication 2014

References:

1. John Twidell, “Renewable Energy Sources”, Taylor and Francis
2. Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, Oxford University Press
3. Ewald F. Fuchs, “Power Conversion of Renewable Energy Systems”, Springer
4. B. H. Khan, “Non Conventional Energy”, Tata McGraw Hill
5. D P kothari ,”Wind energy System and applications” Narosa Pub 2014