Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

M. Tech – Automotive Electronics (MEA)

Curriculum and Syllabus

(*2025-2026 admitted students*)

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

Adaptive Curriculum for Excellence –ACE 2025-26

M. Tech Automotive Electronics

Program Educational Objectives

The engineering graduates of the programme will

1. Establish successful careers in industry, research, and academia, leveraging their expertise in advanced Automotive Electronics.
2. Identify and analyse societal challenges in automotive electronics, carry out independent research, and articulate technological solutions effectively.
3. Effectively collaborate, manage, and execute projects using relevant tools and technologies, upholding professionalism and best practices.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

PO4: Apply advanced concepts of Automotive Electronics to design and develop components and integrated systems for modern automotive applications.

PO5: Utilize state-of-the-art hardware and software tools to develop Automotive Electronic systems in accordance with industry standards and realistic constraints, including safety and public health considerations.

PO6: Identify and address research gaps using Automotive Electronics to develop solutions for socio-economic and environmental challenges.

Curriculum Structure

Program Credit Structure	Credits
University Core Courses	39
Professional Core Courses	24
Professional Elective courses	14
Open Elective Courses	03
Total Graded Credit Requirement	**80**

University Core courses (39 Credits)

S.No	Course Title	L	T	P	C
1	Technical Report Writing	1	0	3	4
2	Qualitative and Quantitative Skills Practice I	3	0	0	3
3	Qualitative and Quantitative Skills Practice II	3	0	0	3
4	Project Work	0	0	0	10
5	Internship I/ Dissertation I	0	0	0	10
6	Internship II/ Dissertation II	0	0	0	10
	Total Credits				**39**

Professional Core Courses (24 Credits)					
S. No	**Name of the Course**	**L**	**T**	**P**	**C**
1	Sensors and Engine Management Systems	3	1	0	4
2	Microcontrollers for Vehicular Systems	3	0	2	4
3	Vehicle Control Systems	3	1	0	4
4	Automotive Networking and Protocols	3	0	2	4
5	Electric and Electronic Power Systems for Vehicles	3	1	0	4
6	Automotive Power Electronics and Motor Drives	3	0	2	4
	Total Credits				**24**

Professional Elective Courses (14 Credits)					
S. No	**Name of the Course**	**L**	**T**	**P**	**C**
1	Vehicular Information and Communication Systems	3	0	0	3
2	Parallel Programming using Multicores and Graphical Processing Units	3	1	0	4
3	Digital Signal Processing and its Applications	3	1	0	4
4	Open Source Hardware and Software System Design	3	0	0	3
5	Machine Vision System for Automotive	3	1	0	4
6	Automotive Fault Diagnostics	3	0	0	3
7	Emission Control and Diagnosis	3	0	0	3
8	Vehicle Safety Systems	3	0	0	3
9	Vehicle Bodies	3	0	0	3
10	Engine Peripherals	3	0	0	3
11	Vehicle Security and Comfort Systems	3	0	0	3
12	Automotive IoT	3	1	0	4
13	Alternative Drives, Traction and Controls	3	0	0	3
14	AR/VR for Automotive Applications	3	0	0	3
15	Soft Computing Techniques	3	1	0	4
16	Embedded System Design	3	1	0	4
17	Electromagnetic Interference and Compatibility	3	0	0	3
18	Machine Learning and Deep Learning	3	1	0	4

<table>
<tr><td>Course Code</td><td colspan="2">Course Title</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>XXXXXXXX</td><td colspan="2">Sensors and Engine Management Systems</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="2"></td><td colspan="4">Syllabus Version</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="4">1.0</td></tr>
<tr><td colspan="7">Course Objectives</td></tr>
<tr><td colspan="7">1.Intrepret Engine sensor waveforms and methods to analyze the same.
2.Provide an overview of petrol and diesel engines using Engine Control Unit (ECU).
3.Discuss the operation of ECU with the suitable mapping of sensors.</td></tr>
<tr><td colspan="7">Course Outcomes</td></tr>
<tr><td colspan="7">1.Analyze responses of Transducers and Sensors for automotive applications.
2. Interpret the concepts of ECU design for automotive applications.
3.Illustrate the operation of petrol and diesel engine management systems.
4.Examine the operation of automotive sensors and fuel injection systems.
5.Apply knowledge of Electronic Control Units (ECUs) related to chassis and body systems to explain their functionality and integration within automotive applications.</td></tr>
<tr><td>Module:1</td><td colspan="2">Automotive Sensors</td><td colspan="4">12 hours</td></tr>
<tr><td colspan="7">Basic Sensors: - Electromagnetic sensors, Hall effect sensors, Capacitive transducers, Piezo electric transducers.
Vehicle Body: - Torque sensors/ Force sensors, Sensors Flap air flow sensors, Temperature sensors, Ultrasonic sensors, Ranging radar
Power Train: - Fuel level sensors, Speed and RPM sensors, Lambda Oxygen sensor, Hotwire air mass meter
Chassis: - Steering wheel angle sensors, Vibration and acceleration sensors, Pressure sensors, Speed and RPM sensors.</td></tr>
<tr><td>Module:2</td><td colspan="2">Electronic Control Unit (ECU) Design</td><td colspan="4">10 hours</td></tr>
<tr><td colspan="7">The concepts of ECU design for automotive applications, Need for ECUs, advances in ECUs for automotive, design complexities of ECUs, V-Model for Automotive ECU’s Architecture, analog and digital interfaces.</td></tr>
<tr><td>Module:3</td><td colspan="2">Basics of Engine Management systems</td><td colspan="4">10 hours</td></tr>
<tr><td colspan="7">IC engines operation – Petrol and Diesel; IC engine as a propulsion source for Automobiles; the need for engine controls and management; Control objectives linked to fuel efficiency, emission limits and vehicle performance; advantages of using electronic engine controls.</td></tr>
<tr><td>Module:4</td><td colspan="2">Petrol and Diesel Engine Management Systems</td><td colspan="4">13 hours</td></tr>
<tr><td colspan="7">Evolution of Petrol engine controls, electronic ignition, multi-point fuel injection, direct injection; Basics of ignition system and fuel injection system; Architecture of an EMS with multi point fuel injection.
Basics of Diesel engine Controls; Evolution of diesel engine controls; in-line fuel pump; rotary fuel pump; EGR control; Electric motor driven fuel pump; electronic fuel injection control and timing.</td></tr>
<tr><td>Module:5</td><td colspan="2">Digital Engine Management Systems</td><td colspan="4">13 hours</td></tr>
<tr><td colspan="7">Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, electronic dashboard instruments – Onboard diagnosis system.</td></tr>
<tr><td>Module:6</td><td colspan="2">Contemporary Issues</td><td colspan="4">2 hours</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td></td><td colspan="2">Total Lecture hours:</td><td colspan="4">60 hours</td></tr>
</table>

Text Books				
1	H.N. Gupta, Fundamentals of Internal Combustion Engines, 2015,2nd Edition, PHI publisher			
2	John Turner & Joe Watson, Automotive Sensors,2009,1st Edition, (Sensors Technology) Momentum Press.			
Reference Books				
1.	V Ganesan, Internal Combustion Engines, 2017,4th Edition. Tata McGraw Hill.			
2.	Alma Hillier, Fundamentals of Automotive Electronics Book,2015,6th Edition, Oxford University Press.			
3.	Bosch, Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, 2013, Springer Science & Business Media.			
Mode of Evaluation: Quiz, Assignment, CAT and FAT				
Recommended by Board of Studies				
Approved by Academic Council		**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Microcontrollers for Vehicular Systems**	**3**	**0**	**2**	**4**
Pre-requisite	**Nil**	**Syllabus Version**			
		1.0			

Course Objectives

1.Examining various automotive-grade microcontrollers for vehicles.
2.Computing using the 8051 microcontroller and ARM processor core-based microcontroller architectures.
3.Applying the architectural design and key features of ARM processor.

Course Outcomes

1.Infer the architecture of 8051 Microcontroller.
2.Solve problems using 8051 Microcontroller.
3.Adapt ARM architecture and its features.
4.Compare the types of automotive grade microcontrollers in the market and infer a suitable choice for an application.
5.Employ Embedded C programs using 8051 and ARM Processor core based microcontroller.

Module:1	**8 bit Microcontroller Architecture**	**7 hours**
RISC vs CISC and Harvard vs Princeton, 8-bit Architecture [8051]: External memory interface, Ports, Timers/counters, Serial Communication and Interrupts, Internal Memory -Types and Access methods.		
Module:2	**8 bit Microcontroller Programming**	**9 hours**
Programming in Embedded C [8051]: using Pressure Sensors for vehicle safety applications, Temperature Sensors for monitoring engine and cabin temperature, Proximity Sensors to assist in parking and collision avoidance.		
Module:3	**ARM Architecture**	**9 hours**
ARM Design Philosophy, Overview of ARM 7 architecture, States [ARM, Thumb, Jazelle], Registers, modes, Conditional Execution, Pipelining, Vector Tables, Exception handling. Architecture of Cortex-M, Architecture of Cortex-R		
Module:4	**Automotive 32-bit MCU**	**11 hours**
Selecting MCU's for Automotive Applications: Atmel automotive-grade microcontrollers (MCUs)-32-bit/DSC, ST- SPC5 32-bit Automotive MCUs, NXP Automotive MCU: NXP S32K microcontrollers, NXP i:MX. Hercules TMS570: TMS570LC4357 Hercules™ Microcontroller. Infineon AURIX TriCore Series. Automotive microcontrollers for Powertrain Control, Hybrid and Electric Auxiliaries, Transmission and Body Electronics, Infotainment and Connectivity.		
Module:5	**ARM core based Microcontroller programming**	**7 hours**
Embedded C programming for Memory Addressing, IO ports, Timers/counter, Watch Dog Timer, PWM, ADC/DAC, UART, Interrupts and Displays, Intro to ML frameworks for embedded devices: TensorFlow Lite and Edge Impulse.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems using Assembly and C -2023, 3rd Edition, reprint, Pearson Education
2	Alexander G. Dean, Embedded Systems Fundamentals with Arm® Cortex®- M based Microcontrollers: A Practical Approach,2021, ISBN: 978- 1- 911531- 26- 5, NUCLEO-F091RC EDITION

Reference Books

1.	Embedded Systems Fundamentals with ARM Cortex-M Based Microcontrollers, 2017, ARM Education Media UK ISBN/ASBN: 978-1911531036

2.	Joseph Yiu, The Definitive Guide to the ARM Cortex M0, 2016, 2nd Edition, Newness
3.	Ronald K. Jurgen, Automotive Microcontrollers, Volume 2, 2007, SAE publications
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	
List of Experiments (Indicative)	

[8051 Microcontroller programming using Embedded C in simulator and implementation in 8051 Microcontroller] (expt. 1 to 5) 1.Programming with Arithmetic logic instructions and I/O programming	**2 hours**
2.Programming with timer/counter – using timer for calculating delay/counting external pulses	**4 hours**
3.Programming with Serial Communication – Serial communication data transfer and receiver	**4 hours**
4.Programming with Interrupt – providing external interrupt to activate ISR	**4 hours**
5.Programming with LCD – Interface LCD to display outputs	**2 hours**
[LPC2148 ARM Microcontroller programming using Embedded C in simulator and implementation in LPC2148 ARM microcontroller] (expt. 6 to 10) 6.Programming with Arithmetic logic instructions – Basic programming like addition, subtraction, multiply, division, AND, OR, NOR, NAND, NOT, XOR.	**2 hours**
7. GPIO programming ARM microcontroller - GPIO programming	**2 hours**
8. Timer programming ARM Microcontroller– using timer for calculating delay	**4 hours**
9.PWM Generation ARM Microcontroller- DC motor control	**4 hours**
10.Role of AI/ML in automotive: Predictive Maintenance/ Driver Monitoring/ Smart Diagnostics/ Feature Extraction & Model Deployment of Cortex-M using TFLite Micro	**2 hours**
Total Laboratory Hours	**30 hours**
Mode Evaluation: Continuous Assessment and Final Assessment Test.	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	Vehicle Control Systems	3	1	0	4
Pre-requisite	Nil	Syllabus Version			
		1.0			

Course Objectives

1.Illustrate the dynamic system modeling using transfer function approach and performance of first and second-order feedback control systems,
2.Examine stability using frequency domain methods and optimize the control systems utilizing controllers, compensators and AIML techniques.
3.Familiarize the state-space design methods for SISO and MIMO systems and discrete-time control design.

Course Outcomes

1.Develop the mathematical models for electrical systems, mechanical systems, block diagrams and signal flow graphs using transfer function approach.
2.Analyze the time-domain and steady state response of first and second order control systems.
3.Analyze the system performance and stability using time and frequency domain methods.
4.Apply frequency domain and AIML techniques to design compensators and controllers.
5.Apply state-space methods, stability tests, and sampling techniques for analog and digital control systems.

Module:1	System Modeling using Transfer function	11 hours

Fundamentals of modeling -transfer function approach-Electrical, Mechanical systems-translational and rotational, Analogous Systems-Force Voltage and Force-Current analogy, DC servomotors-Field controlled and armature-controlled methods. Introduction to block diagrams & signal flow graphs, block diagram from signal flow graph. Introduction to SIMULINK.

Module:2	Performance of Feedback Control System	12 hours

First order, Second order control system response for step, ramp and impulse inputs. Type number -characteristic equation -Poles and Zeroes concept, time domain specifications. Error Analysis, effect of input and open loop transfer function on steady sate error, Dynamic error coefficients, feedback characteristics of control systems, and performance indices.

Module:3	Stability analysis of feedback control system	10 hours

Concept of stability, Routh Hurwitz stability criteria, Root Locus, Design via Gain Adjustment, root sensitivity- Frequency response plots -frequency domain specifications -stability analysis: stability in the frequency domain –Bode plot, Polar plot, Nyquist stability criterion.

Module:4	Controller and compensator Design	12 hours

Design of P, PI, and PID control actions –Root locus method. Classical design in the frequency domain- lead, lag compensator design. Design of control systems using machine learning and deep learning techniques.

Module:5	State-Space Analysis and Digital control systems	13 hours

State space design methods: SISO, MIMO systems, State and Output Equations; Controllability and Observability, Discrete Time systems, Sampling and aliasing considerations, System time response, characteristics -Jury 's stability test. -mapping s to z plane -Digital controller design: from analog to digital design.

Module:6	Contemporary Issues	2 hours
	Total Lecture hours:	60 hours

Text Books			
1	Norman S. Nise, Control Systems Engineering, 2019, 8th Edition, Wiley, India.		
2	Nagrath and M. Gopal, Control System Engineering, 2021, 7th Edition, Prentice Hall, India.		
Reference Books			
1.	Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 2022, 14th Edition, Pearson, India.		
2.	Jinkun Liu, Intelligent control design and MATLAB simulation, 2018, Springer, Singapore.		
3.	Benjamin C. Kuo, Automatic Control Systems, 2014, 9th Edition, Wiley, India.		
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

<table>
<tr><th>Course Code</th><th colspan="2">Course Title</th><th>L</th><th>T</th><th>P</th><th>C</th></tr>
<tr><td>XXXXXXXX</td><td colspan="2">Automotive Networking and Protocols</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="2"></td><td colspan="4">Syllabus Version</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="4">1.0</td></tr>
<tr><td colspan="7">Course Objectives</td></tr>
<tr><td colspan="7">1.Providing students with a working knowledge of In-Vehicle network systems
2.Acquainting aspects of design, development, application and performance issues associated with vehicle networking systems.
3. Illustrating concepts of sensor data capture, storage and exchange of data to access remote services</td></tr>
<tr><td colspan="7">Course Outcomes</td></tr>
<tr><td colspan="7">1.Infer the need for In-Vehicle Networking and the basics of data communication, networking and concept of Automotive Software- AUTOSAR.
2.Apply the CAN and CAN higher layer protocols like CAN open, DeviceNet, TTCAN and SAE J1939 usage in the automotive sector.
3.Classify LIN, MOST protocol and FlexRay protocol used in automotive applications.
4.Identify the role of automotive Ethernet, TSN technologies and automotive cyber security in modern vehicle communication systems.
5.Implement automotive network protocols for real-world applications.</td></tr>
<tr><td>Module:1</td><td colspan="4">Fundamentals of Automotive Networking and Automotive Software</td><td colspan="2">10 hours</td></tr>
<tr><td colspan="7">Fundamentals of Data communication System, Components, Performance metrics, Network topologies, OSI & TCP/IP models; Emphasis on the Data Link Layer and its sublayers; Logical Link Control (LLC) : Framing and flow control; Error detection and correction techniques; Medium Access Control (MAC) protocols - Random Access :CSMA, CD versus CA; Line coding and block coding methods; DSRC and IEEE 802.11p (WAVE); Cellular technologies: GSM, LTE, 5G and their role in telematics, OTA updates, and cybersecurity considerations; V2X communication types: V2V, V2I, V2P, V2D, V2G, V2C, V2X; C-V2X architecture and comparison with DSRC; VANETs vs MANETs; safety vs comfort applications in VANETs. Multiplexing techniques; Need for in-vehicle networking; Software abstraction through AUTOSAR architecture.</td></tr>
<tr><td>Module:2</td><td colspan="4">Controller Area Network (CAN) and Higher Layer Protocols</td><td colspan="2">10 hours</td></tr>
<tr><td colspan="7">Controller Area Network (CAN) and Time-Triggered Communication – Introduction to CAN protocol: features, architecture, and applications in in-vehicle networking; CAN frame structure: base and extended frames, arbitration, bit stuffing, and CRC; CAN physical and data link layer details; error handling and fault confinement mechanisms; baud rate, synchronization, and bus loading concepts; Higher Layer Protocols: CANopen, DeviceNet, and SAE J1939, CAN FD; need for deterministic communication in safety-critical systems; limitations of event-triggered CAN; introduction to Time-Triggered CAN (TTCAN) for real-time and scheduled message transmission; TTCAN communication cycle and global time synchronization; use cases of TTCAN in automotive safety and automation systems.</td></tr>
<tr><td>Module:3</td><td colspan="4">Automotive Protocols for Body, Safety and Infotainment</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="7">Overview of LIN (Local Interconnect Network): architecture, master-slave scheduling, frame structure, checksum, and use in body control modules; FlexRay protocol: need for fault tolerance and high data rates, static vs dynamic segments, global time synchronization, dual-channel operation, and configuration; MOST (Media Oriented Systems Transport): Topology, Application Framework, Function Blocks, use in multimedia systems; Timing Master - Data Flow. network security in automotive systems: attack types and security solutions.</td></tr>
<tr><td>Module:4</td><td colspan="4">Automotive Ethernet</td><td colspan="2">7 hours</td></tr>
<tr><td colspan="7">Introduction to Ethernet in Automotive Networks: ; frame structure, MAC addressing, Ethernet types (e.g., 100BASE-T1, 1000BASE-T1) ; Automotive Ethernet standards: BroadR-Reach ; Time-Sensitive Networking (TSN): introduction to IEEE 802.1Qbv, 802.1AS, 802.1Qbu; protocols for automotive</td></tr>
</table>

Ethernet: Dynamic Service Oriented architecture: Evolution of AUTOSAR for Ethernet stack ; SOME/IP, DoIP.		
Module:5	**Automotive Security**	**8 hours**
Introduction to Cybersecurity: Security concepts, security attacks and risks, architectures, policy management, security mechanisms; challenges associated with vehicle connectivity:V2I, V2V, and V2IoT communication, security concerns in intelligent transport systems that interact with the vehicle, focusing on telematics, cryptography, security standards, security system interoperation of security system; case studies of the automotive security systems and connectivity technologies provide insights into real-world applications, automotive cyber security and autonomous vehicles, IT Security in Automotive Cyber-Physical Systems.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1	D. Paret and H. Rebaine, Autonomous and Connected Vehicles: Network Architectures from Legacy Networks to Automotive Ethernet, 2022,1st Edition, John Wiley & Sons.
2	D. P. M¨oller and R. E. Haas, Guide to Automotive Connectivity and Cyber security: Trends, Technologies, Innovations and Applications, 2019, Springer International Publishing.
Reference Books	
1.	B. A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, 2021, 6th Edition, McGraw-Hill Education.
2.	D. Paret, Multiplexed Networks for Embedded Systems CAN, LIN, FlexRay, Safe-By-Wire, Jun. 2007,1st Edition, Nashville, TN: John Wiley & Sons.
3.	W. Voss, A comprehensible guide to controller area network, 2008, Copperhill Media.
4.	A. Grzemba, MOST: the automotive multimedia network, Jan. 2012, ser. Netzwerk. Haar, Germany: Franzis.
5.	K. Matheus and T. K¨onigseder, Automotive Ethernet, Apr. 2021, Cambridge University Press.
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	

List of Experiments (Indicative)		
1	Introduction to LabView	**2 Hours**
2	TCP/IP communication using LabView- Sending data to particular port address using TCP/IP protocol	**4 Hours**
3	TCP/UDP communication using LabView- Sending data to particular port address using TCP/UDP protocol	**4 hours**
4	Introduction to AUTOSAR Support in MATLAB and Simulink	**2 hours**
5	(a) LIN node to node communication using HCS512 microcontroller. (b) Data will be sent and received from master and slave node using LIN protocol	**4 hours**
6	(a) CAN node to node communication using MCP2515, HCS512 microcontroller. (b) Data will be sent and received from master and slave node using CAN protocol	**4 hours**
7	MATLAB functions and Simulink blocks for sending, receiving, encoding, and decoding CAN using MATLAB Vehicle Network Toolbox.	**4 hours**

8	MATLAB functions and Simulink blocks for sending, receiving, encoding, and decoding CAN-FD using MATLAB Vehicle Network Toolbox.	**4 hours**
9	Basics of socket CAN in LINUX – CAN.	**2 hours**
Total Laboratory Hours		**30 hours**
Mode Evaluation: Continuous Assessment and Final Assessment Test.		

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Electric and Electronic Power Systems for Vehicles**	**3**	**1**	**0**	**4**
Pre-requisite	**Nil**	**Syllabus Version**			
		1.0			

Course Objectives

1.Preparing Students to develop the skills to interpret the Circuit, Electrical wiring diagram and Batteries
2.Imparting the operation of Automotive Electrical systems with emphasizing on Charging, Ignition, Lighting systems and Sensors
3.Imparting Students the knowledge about the new developments and advancements of Automotive Electrical Technologies

Course Outcomes

1.Interpret the fundamental concepts of Electrical wiring, role of Batteries in Vehicles and Charging Systems
2. Illustrate the Starter, Ignition systems and Lighting Systems in Vehicles.
3. Infer the Lighting Systems in Vehicles.
4. Examine the Sensors for Automotive Systems
5.Investigate on the recent developments in Vehicle batteries, Charging, Starting, Ignition and Lighting Systems in Vehicles

Module:1	Electrical Systems,Lead-Acid Batteries and Nickel based Batteries	15 hours

System approach,electrical wiring,terminals and switching,multiplexed wiring systems,SAE J1939 Standards Collection,circuit diagrams and symbols.
Lead-Acid Batteries : Vehicle Batteries,Overview of Batteries for future automobiles,Lead-acid batteries fundamentals,Modelling and Simulation,Heavy trucks,E-bicycles and E-Scooters, Standards and Tests,Recycling concepts for sustainability,Development trends for Future Automobiles and their demand,New Batteries technologies.
Nickel based Batteries:Nickel Cadmium,characteristics,Nickel-Metal Hydride,characteristics, Nickel-Iron,characteristics,Nickel-Zinc,characteristics.

Module:2	Heavy Vehicles and Charging Systems	12 hours

Heavy Vehicles :Requirements for two wheeler, three wheeler and heavy vehicles,Pathways to zero-emission,Truck deployment and policy,Standards and specifications.
Charging Systems:Requirements,generation of Electrical energy in motor vehicle,physical principles,Alternators,Characteristic curves,Charging circuits,Diagnosing charging system faults,Recent developments.

Module:3	Starting and Ignition system	12 hours

Starting System:Requirements,Starter motors and circuits,types of Starter motors,diagnosing starting system faults.
Ignition System:Fundamentals,Electronic ignition,Programmed ignition,Distributor less ignition,Direct ignition,Spark plug ignition,Diagnosing faults, Recent developments.

Module:4	Automotive Lighting system	9 hours

Lighting fundamentals,Insulated and earth return systems,positive and negative earth systems,lighting circuits,Gas discharged and LED lighting,diagnosing lighting system faults, advanced lighting technology,glare and preventive methods,innovations,future technology and trends in automatic lighting, AI Use cases in Lighting control.

Module:5	Sensors for Automotive Systems	10 hours

Electrical fuel pump, Speed warning systems,Oil pressure warning and Engine over heat warning system,Windshield Wiper and Washers,Power windows, seats, door locks, Air bag systems, Seat belt pretensioners,Oxygen Sensor,Cranking Sensor,Position Sensors,Engine cooling water temperature Sensor,Engine oil pressure Sensor,Fuel metering,Vehicle speed sensor and detonation sensor.

Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Books

1.	Tom Denton, Hayley Pells,Automobile Mechanical and Electrical Systems, 2023, 3rd Edition, Routledge, ,USA.
2	William B Ribbens, Understanding Automotive Electronics, An Engineering Perspective, 2017, 8th Edition, Butterworth-Heinemann Inc, USA.

Reference Books

1.	Tom Denton, Automobile Electrical and Electronics System and Components, 2015, 3rd Edition, Elsevier, USA.
2.	Robert Bosch, Gmbh,Automotive Hand Book,2022,11th Edition, Wiley-Blackwell,USA.
3.	Ju¨rgen Garche,Eckhard Karden,Patrick T. Moseley,David A.J. Rand,Lead Acid Batteries for Future Automobiles,2017,1st Edition,Elsevier,USA.
4.	Christian Glaize,Sylvle Genies,Lead and Nickel Electrochemical Batteries,2012,1st Edition, Wiley,USA.
5.	Robert Bosch Gmbh , Bosch Automotive Electrics and Automotive Electronics Systems and Components,2014, 5th Edition,Springer Nature,Germany.
6.	Transforming Trucking in India Pathways to Zero-Emission Truck Deployment,2022,NITI Aayog,RMI.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXX	Automotive Power Electronics and Motor Drives	3	0	2	4
Pre-requisite	Nil	Syllabus Version			
		1.0			

Course Objectives

1. Imparting an in-depth knowledge about power electronics devices.
2. Enable the students to understand the operation of converters and application of AIML Algorithms.
3. Explore the performance characteristics of motors and different speed control techniques.

Course Outcomes

1.Analyze the power electronic devices for automotive applications.
2.Analyze the operation of AC-DC converters at different loads.
3.Apply the principles of inverters, chopper circuits, and PWM control techniques, including machine learning-based methods for efficient power conversion and control.
4.Apply various speed control methods for DC, induction, and BLDC motors based on their construction, characteristics, and operating principles.
5.Simulate and examine the performance analysis of power devices, converters and motor drives.

Module:1	Power Electronic devices	6 hours

Introduction to power electronics - structure, operation and characteristics of automotive semiconductor devices-Power Transistor, Power MOSFET, -SCR, IGBT, turn on and off circuits – series and parallel operation of SCR –protection Circuits –design of snubber circuits.

Module:2	Phase controlled Rectifiers	9 hours

Single phase half and full wave-controlled converter with R, RL, RLE loads, -Three phase half and fully controlled converter with R-RL loads, effect of source impedance on the performance of converters.

Module:3	Inverters	10 hours

Single phase voltage source inverter- three phase Voltage source inverter with 120 degree and 180 degree conduction mode-current source inverters – PWM techniques, Machine Learning Techniques-PWM control, Applications-Electric and hybrid vehicles

Module:4	DC-DC Converters	10 hours

Principle of chopper operation, Control strategies- constant frequency system and variable frequency system; Step up and step-down choppers. Machine learning algorithms-output control, Applications-Electric and hybrid vehicles

Module:5	Automotive motor drives and Control	8 hours

Methods of controlling speed – Induction and DC Motors, BLDC Motor construction, characteristics and operation

Module:6	Contemporary Issues	2 hours
	Total Lecture hours:	45 hours

Text Books

1.	Bimal K Bose, Power Electronics and Motor Drive: Advances and Trends, 2020,2nd edition Academic Press.
2.	P.S. Bimbhra, Power Electronics, 2022,14th edition Khanna Publishers.

Reference Books

1.	Ali Emadi, Handbook of automotive power electronics and motor drives, 2017, CRS press.
2.	Stefanos N. Manias, Power Electronics and Motor Drive systems,2017, academic press.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT

List of Experiments (Indicative)		
1.	Study of transfer and output characteristics of MOSFET.	**4 hours**
2.	Study of anode characteristics of SCR.	**4 hours**
3.	Design and simulate a Single Phase half wave controlled converter with R, RL and RLE load using MATLAB Simulink.	**4 hours**
4.	Design and simulate a Three Phase half wave controlled converter with R, RL, RLE load using MATLAB Simulink.	**4 hours**
5.	Design and simulate a Three Phase voltage source inverter (VSI) 120 and 180 degree mode of conduction using MATLAB Simulink.	**4 hours**
6.	Performance evaluation of Step-up-chopper and step-down chopper using MATLAB Simulink.	**4 hours**
7.	Performance evaluation of a Separately Excited DC Motor Drive using MATLAB Simulink.	**4 hours**
8.	Performance evaluation of a V/f-controlled induction motor drive.	**2 hours**
Total Laboratory Hours		**30 hours**

Mode of Evaluation: Continuous Assessment and Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Vehicular Information and Communication Systems**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Acquaint students with concepts of data processing, instrumentation and Electronic Control Unit (ECU).
2. Providing students with a good understanding about automotive sound systems and navigation for vehicular systems.
3. Imparting knowledge about the positioning and guidance systems.

Course Outcomes

1. Apply data processing principles to analyze and troubleshoot automotive systems in motor vehicles.
2. Analyze automotive networking protocols and architectures to design and optimize vehicle communication systems.
3. Apply knowledge of ECU recording equipment to diagnose and resolve issues in automotive electronics and analyze sound system designs to enhance audio quality in vehicles.
4. Examine the Positioning, Route planning and route guidance for automotive vehicles.

Module:1	**Data processing in motor vehicles**	**8 hours**

Requirements, Electronic Control Unit (ECU), Architecture, CARTRONIC, Advanced Data Processing in In-Vehicle Communications.

Module:2	**Automotive networking**	**8 hours**

Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Real-Time Automotive Networking Examples, Applications in EVs and Autonomous Vehicles

Module:3	**Instrumentation**	**8 hours**

Information and communication areas, Driver information systems, Instrument clusters, Display types, Automotive Communication Interfaces: CAN, MOST, and FlexRay in Instrumentation.

Module:4	**ECU recording equipment and Automotive sound systems**	**9hours**

Legal requirements, Design variations, parking aid with ultrasonic sensors, Further Development, Radio tuners, Conventional tuners, Digital receivers, Reception quality, Reception improvement, Auxiliary equipment, Vehicle antennas.

Module:5	**Positioning Route Planning and Route Guidance**	**10 hours**

Dead Reckoning, Global Positioning System, Sensor fusion. Conventional map matching, Seamless Connectivity: Integration of Bluetooth, USB, and Wi-Fi in Automotive Systems, Fuzzy logic Based Map matching, Map aided Sensor calibration, Shortest Path, Heuristic Search, Bidirectional Search, Hierarchical search, Guidance while En Route, Guidance while off Route, Guidance with dynamic information and contemporary Issues.

Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	Bosch, Automotive Handbook,2022, 11th Edition, SAE publication.
2.	Yilin Zhao –Vehicle location and Navigation Systems, 2016,1st Edition, Artech House Inc.,

Reference Books

1.	L Vlacic, M Parent, F Harashima, Intelligent Vehicle Technologies Theory and Applications, 2015,1st Edition, Butterworth Heinemann.
2.	Sussman, Joseph. Perspectives on Intelligent Transportation Systems (ITS). 2010,1st Edition, Springer, New York.

3.	Mashrur A. Chowdhury, and Adel Sadek, Fundamentals of Intelligent Transportation Systems Planning,2003,1st Edition, Artech House, Inc.			
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT				
Recommended by Board of Studies				
Approved by Academic Council		**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Parallel Programming using Multicores and Graphical Processing Units**	**3**	**1**	**0**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Enabling the students to understand the scope, design and model of parallelism and to know the parallel computing architectures.
2. Imparting the skills students to do analytical modeling and performance of parallel algorithms in shared memory architecture and message passing distributed programming model.
3. Programming GPU with CUDA and analyzing complex problems with shared memory Programming.

Course Outcomes

1. Develop the foundation knowledge about parallel processing and architectures.
2. Analyse various parallel computation patterns in shared memory architecture.
3. Realize the distributed parallel architecture with message passing model.
4. Simulate the kernel based parallel programming concepts using CUDA kernal.
5. Apply and analyse the performance considerations for parallel processing in GPU accelarated Libraries.

Module:1	**Overview of Multi-core Architecture and Threading**	**8 hours**

Overview of Single core processor Architecture and its limitations, Architectural Innovations, Need for Multi-core Processor and its Limitations, Classification Multicores, Multicore system software stack - Defining threads – threads inside the OS – threads inside the hardware – Application programming models and threading – virtual environment – Run time virtualization – System virtualization.

Module:2	**OpenMP : Portable solution for threading**	**13 hours**

Loop carried dependence – Data-race conditions – Managing shared and private Data – Loop Scheduling and Partitioning – Effective use of reductions – work-sharing sections – Using barrier and Nowait – Interleaving single thread and multi-thread execution – Data copy-in and copy-out – Protecting updates of shared variables – OpenMP Library functions – OpenMP environmental variables – multithreading debugging techniques.

Module:3	**MPI Message Passing Interface**	**13 hours**

MPI basics, point-to-point communication, collective communication,synchronous/asynchronous send/recv, algorithms for gather, scatter, broadcast, reduce.

Module:4	**CUDA Kernel-Based Parallel Programming**	**13 hours**

GPUs as Parallel computers – architecture of a modern GPU – Data Parallelism – CUDA program structure – Matrix – Matrix multiplication example – Device memories and data transfer – Kernel functions and threading – predefined variables – Runtime API - CUDA thread organization – Using block and thread – synchronization and Transparent Scalability – Thread Assignment – Thread scheduling – CUDA device memory types – strategy for reducing global memory traffic

Module:5	**GPU-Accelerated Libraries**	**11 hours**

Accelerated linear algebra (BLAS) library - Accelerated random number generation (RAND) - NVIDIA TensorRT - CUDA Deep Neural Network library (cuDNN)

Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Books

1.	AnantaGrama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2011,2nd Edition, Addison Wesley Professional, UK.

2.	Pacheco, Peter. An Introduction to Parallel programming, 2021, 2nd Edition, Morgan Kaufmann Publishers, USA.		
Reference Books			
1.	Gabriele Jost and Ruud van der Pas, Portable Shared Memory Parallel Programming , 2007, The MIT Press, USA.		
2.	William Gropp and Ewing Lusk, Portable Parallel Programming with the Message Passing Interface, 2009, MIT Press, USA.		
3.	David B. Kirk and Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 2016, 3rd Edition, Morgan Kaufmann Publishers, USA.		
4.	CUDA cuBLAS Release 12.8, NVIDIA Corporation, 2025.		
5.	CUDA cuTENSOR Release 2.2.0, NVIDIA Corporation, 2025.		
6.	CUDA cuDNN Release 2.2.2, NVIDIA Corporation, 2025.		
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXX	**Digital Signal Processing and Its Applications**	**3**	**1**	**0**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Acquaint students with fundamentals of Digital Signal Processing (DSP) Concepts
2. Familiarize the Digital Signals and Systems.
3. Illustrate the Implementation of DSP Techniques in Real-world Applications.

Course Outcomes

1. Implement concepts of sampling, quantization, and A/D and D/A conversions in basic DSP system design and analysis.
2. Examine digital signals and systems using DFT, FFT, Z-transform, and spectral analysis methods.
3. Utilize polyphase filter structures for decimation, interpolation, and sampling rate conversion in DSP-based systems.
4. Apply source coding techniques to speech and image signals, and analyze efficiency in terms of entropy, compression, and relevance to big data and machine learning.
5. Analyze the architecture, hardware components, numerical formats, and software implementations of real-time DSP programming on industry-standard platforms.

Module:1	**Overview of Digital Signal Processing and its Applications**	**12 hours**

Digital Signal Processing basics: continuous and discrete signals, Sampling and reconstruction, Quantization, Analog-to-Digital conversion, Digital-to-Analog converters, Transform analysis of Linear Time-Invariant Systems: Discrete Fourier Transform and Fast Fourier Transform: Spectral analysis, "Z" Transforms using the auto-correlation function, Periodogram averaging, Parametric spectrum analysis. -Typical Digital Signal Processing in real-world applications: Interference cancellation in Electrocardiography, Speech coding and compression, Digital image enhancement, Telecommunications, Automotive.

Module:2	**Adaptive Digital Systems**	**11 hours**

Introduction: system structure, The processor and the performance function: the Adaptive Linear Combiner, The performance function, Adaptation algorithms: The method of steepest descent, Newton’s method, The Least Mean Square algorithm, Applications: Adaptive Interference Channel, Equalizers, Adaptive beam forming, Kalman filters: Recursive least square estimation, The pseudo-inverse, The Kalman filter: The signal model , The filter, Kalman filter properties , Applications.

Module:3	**Multirate Signal Processing**	**11 hours**

Decimation, Interpolation, Sampling Rate conversion by a rational factor I/D, Multistage implementation of sampling rate conversion, Polyphase filter structures, Applications of multirate signal processing.

Module:4	**Data Compression**	**12 hours**

An information theory primer: Information and entropy, Source coding : Huffman algorithm, Delta modulation, Adaptive delta modulation and continuously variable slope delta modulation, DPCM adaptive DPCM techniques, Speech coding, adaptive predictive coding and sub-band coding, Vocoders and linear predictive coding , JPEG, MPEG, MP3, The Lempel–Ziv algorithm, Recognition techniques: Speech recognition, Image recognition, Advanced Topics and Emerging Trends: Compression in big data, Compression for machine learning, Future trends in data compression

Module:5	**Hardware and Software for Digital Signal Processors**	**12 hours**

Overview of DSP architecture, Hardware components such as MAC units, Shifters, and address generators; Numerical formats including Fixed-point and Floating-point representations; FIR and IIR filter structures in fixed-point systems; Real-time DSP platforms like TMS320C6713; Applications in adaptive filtering, Signal quantization using TMS320C6713 DSK, and Sampling rate conversion using the TMS320C6713 DSK.

Module:6	**Contemporary Issues**	**2 hours**

			Total Lecture hours:	**60 hours**
Text Books				
1.	J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 2021, 5th Editon, Pearson, USA.			
2.	R. Chassaing and D. Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, 2008, 2nd Education, Hoboken, NJ, USA: Wiley-IEEE Press.			
Reference Books				
1.	Tan, Li, and Jean Jiang, Digital signal processing: fundamentals and applications, 2018, 3rd Edition, Academic press, USA.			
2.	Salomon, David, Data compression, 2007, 4th Edition, Springer, USA.			
3.	Dag Stranneby and William Walker, Digital signal processing and applications, 2015, 2nd Edition, Elsevier, New York.			
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT				
Recommended by Board of Studies				
Approved by Academic Council		**No.**	**Date**	

Course Code	Course Title	L	T	P	C
xxxxxxx	**Open Source Hardware and Software System Design**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Familiarizing the foundation of open source hardware and software programming.
2. Providing network, client-server architectural model for web applications.
3. Implementing IIoT projects using Raspberry Pi

Course Outcomes

1. Infer the importance of Open Source programming, GUI programming and web based applications.
2. Examine database operations for Embedded Applications
3. Analyze the operation of different type of Networking and Socket programming.
4. Implement the real-world problems using Raspberry Pi and GPIO Interface.

Module:1	Basics of Python Programming, GUI and Web programming	9 hours

Overview of Open Source Hardware and Software System Design, Python Basics, Variable types – basic operators – decision making – loops –Data Structures – strings- Lists – Tuples –Dictionary – Date and Time – Functions – Modules - File Handling – Exceptions – Object-Oriented Programming (OOP)- Explore ML, python module like - NumPy, Pandas, and Matplotlib; Web Development Basics-Tkinter Programming – Tkinter Widgets - Common Gateway Interface (CGI) – Web server support – Environmental variables – GET and POST methods – Passing information using POST method

Module:2	Database Systems and SQL Operations	9 hours

Database Fundamentals, Concepts of a Database, Architecture, Advantages of Database Systems in Real-Time Applications, Structured Query Language (SQL), data types and constraints in MySQL, MySQLdb – database connection – SQL for data definition- Creating database table - INSERT – READ – UPDATE– DELETE -DROP– COMMIT – ROLEBACK, SQL for data ManipulatIon, Working with Multiple Tables, Aggregating and Grouping Data, SQL Commands, SQL for data Query, data updatIon and deletion

Module:3	Network Programming	7 hours

Fundamental of Network Programming, Sockets – Server socket – Client Socket – General Socket methods – Sockets, IPv4, and Simple Client/Server Programming- Sending an HTTP email – Sending an attachment as an email, Send email to multiple recipients using Python, Multiplexing Socket I/O for Better Performance, IPv6, Unix Domain Sockets, and Network Interfaces, Programming with HTTP for the Internet, Email Protocols, FTP, and CGI Programming.

Module:4	Basic Projects with Raspberry Pi	9 hours

Introduction to RaspberryPi, Architecture – Operating System & Linux Basics- setting up the Raspberry Pi – Interacting with Raspberry command line –Setting up I2C, serial port – Connect Pi to network; Introduction to Python for embedded systems, Exploring GPIO (General Purpose Input/Output) programming, Interfacing of different peripherals: sensors and actuators, LED – Buzzing sound – Switch high power DC source using transistor and relays – controlling high voltage AC device – Using PWM pulses for control – Pi to run different types of motors– Displaying HD images – Playing music- – Controlling GPIO output – Detecting GPIO input – detecting methane – measuring acceleration – measuring temperature – measuring distance – logging into a USB, flash drive.

Module:5	Industrial Internet of Things using Raspberry Pi	9 hours

Fundamentals of the Industrial IoT (IIoT), including IIoT architectures, technologies, protocols, Industrial IoT- Layers: Perception Layer- collect real-time data using sensor; Network Layer- MQTT, CoAP, HTTP, HTTPS, and industrial Ethernet; Processing Layer- analyze and process collected data; Application Layer- dashboards, and analytics tools for monitoring and decision-making. Use of machine learning in IIoT. Case Study: Raspberry Pi for predictive maintenance in factories, Smart grid

applications using Raspberry Pi, IoT-Based Security System, IoT Water Pollution Monitor Remote Control Boat. IIoT security and vulnerability threats.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1.	Lutz, Mark. Learning python: Powerful object-oriented programming. 2025, 6th Edition, O'Reilly Media, Inc.
2.	Simon Monk, Programming the Raspberry Pi, 2021, 3rd Edition, McGraw Hill TAB.
Reference Books	
1.	Jesper Wisborg Krogh, MySQL Connector/Python Revealed: SQL and NoSQL Data Storage Using MySQL for Python Programmers, 2018, Publisher: Apress.
2.	Kathiravelu, Pradeeban_Sarker, Dr. M. O. Faruque - Python Network Programming Cookbook, 2017, Packt Publishing.
3.	Veneri, Giacomo, and Antonio Capasso, Hands-on industrial Internet of Things, 2024, Packt Publishing Ltd,.
4.	John C. Shovic, Raspberry Pi IoT Projects: Prototyping Experiments for Makers,2016, APress.
5.	Derek Molloy, Exploring Raspberry Pi Interfacing to the Real World with Embedded Linux, 2016, John Wiley & Sons, Inc,.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	Machine Vision System for Automotive	3	1	0	4
Pre-requisite		Syllabus Version			
		1.0			

Course Objectives

1. Providing the basic concepts of digital image processing and related algorithms.
2. Introducing the concepts of motion estimation, multi camera view processing and depth Estimation.
3. Elaborating on automation considerations and automotive components testing.

Course Outcomes

1. Apply the fundamental concepts of digital image processing, image formation, and camera geometry in practical scenarios.
2. Analyze the principles of motion estimation, stereo vision, and depth estimation using multi-camera views.
3. Implement core image processing techniques to address computer vision challenges in automotive systems.
4. Evaluate the role of machine vision in automation, safety, and testing in the automotive domain.
5. Examine emerging trends such as Edge AI and Federated Learning, along with ethical implications of computer vision applications.

Module:1	Introduction to Machine Vision Systems	10 hours

Overview of Industrial machine vision. Components of a machine vision system: lighting, lens, sensor, processor. System architecture: Types of Sensors, Camera interfaces and video standards. Digital image fundamentals: image formation, sampling, quantization, color models. Image acquisition hardware, performance considerations. Adjacency conventions.

Module:2	Image Processing Techniques	12 hours

Photometric image formation, Geometric primitives and transformations, Point operators, Linear filtering, Non-linear filtering, Histogram processing: histogram equalization, contrast stretching, Geometric transformations, Fourier transforms, Pyramids and wavelets, Restoration, Edge detection: Sobel, Prewitt, Canny, Morphological operations: dilation, erosion, opening, closing.

Module:3	Feature Extraction and Object Recognition	14 hours

Stereo vision: Perspective, Binocular Stereopsis, Camera and Epipolar Geometry, Homography, Rectification, Direct Linear Transformation (DLT), Random Sample Consensus (RANSAC), 3-D reconstruction framework, Auto-calibration. Feature level analysis: Region of Interest (ROI) extraction, Contour detection, shape analysis, moments, Texture and color-based features, template matching. Edge detectors: Canny, Laplacian of Gaussian (LOG), Difference of Gaussians (DOG); Line detectors: Hough Transform; Corners – Harris and Hessian Affine; Advanced feature descriptors: Scale-Invariant Feature Transform (SIFT), Speeded-Up Robust Features (SURF), Histogram of Oriented Gradients (HOG), Gradient Location and Orientation Histogram (GLOH).

Module:4	Machine Learning and Deep Learning Techniques for Embedded Vision Systems	12 hours

Support Vector Machine, decision trees, k-Nearest Neighbour, suitability and trade-offs for embedded vision tasks. Neural networks, Lightweight Neural Network deployment strategies-quantization, pruning, Knowledge distillation. CNN for image classification and object detection, Training, validation, and evaluation metrics. Lightweight CNN Architectures for Embedded Systems-MobileNet, EfficientNet-Lite, SqueezeNet, Tiny-YOLO.

Module:5	Advanced Topics and Automotive Applications	10 hours

Structure from motion, Simultaneous Localization and Mapping (SLAM), Translational alignment, Parametric motion, Optical flow, Layered motion.

Recent trends: Edge AI, federated learning, ethical implications of vision systems. Applications: driver assistance, autonomous vehicles, inspection systems

Module:6	Contemporary Issues		2 hours
		Total Lecture hours:	60 hours

Text Books	
1.	Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, Machine Vision, 2016, Reprint Edition, Indo American Books, India.
2.	Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 2022, 4th Edition, Pearson Education
Reference Books	
1.	Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing, Analysis, and Machine Vision, 2014, 4th Edition, Cengage Learning, USA.
2.	Richard Szeliski, Computer Vision: Algorithms and Applications, 2022, 2nd Edition, Springer, Germany.
3.	Carsten Steger, Markus Ulrich, Christian Wiedemann, Machine Vision Algorithms and Applications, 2018, 2nd Edition, Wiley-VCH, Germany.
4.	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016, 1st Edition, MIT Press, USA.
5.	Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, 2012, 1st Edition, Cambridge University Press, UK.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	Automotive Fault Diagnostics	3	0	0	3
Pre-requisite		Syllabus Version			
		1.0			

Course Objectives

1. Acquaint students with the basic concepts of automotive fault diagnostics
2. Familiarize the fault diagnostics using tools and equipment
3. Expose students to case studies and real-world diagnostic applications using simulation and hands-on tools.

Course Outcomes

1. Analyse the basic concepts of fault diagnosis in the automotive field.
2. Apply standard diagnostic protocols like OBD-II, CAN, and UDS in fault detection.
3. Identify faults in engine, transmission, breaking, and electrical systems using logical and tool assisted approaches.
4. Examine different failure scenarios associated with electronic control units and the approaches used to diagnose faults in electrical systems.

Module:1	Fundamentals of Fault Diagnostics	10 hours

Fundamentals of diagnostics in modern vehicles -Types of faults: permanent, intermittent, transient - Fault symptoms and failure modes - Diagnostic process and workflow - Importance of diagnostics in automotive safety and emissions - Tools and methods: visual inspection, scan tools, oscilloscopes

Module:2	Diagnostics Methods	9 hours

OBD evolution: OBD-I to OBD-II and beyond - OBD-II architecture and communication protocols - Diagnostic Trouble Codes (DTCs): Types and interpretation - Freeze frame and live data analysis - Emissions-related monitoring - Introduction to EOBD, HD-OBD, and UDS protocols.

Module:3	Engine System Diagnosis	9 hours

Engine management systems diagnostics - Air intake, fuel injection, ignition, and exhaust subsystems - Misfire detection and emission fault detection - Transmission diagnostics: AT, CVT, DCT systems - Use of pressure and vacuum gauges, exhaust analyzers.

Module:4	Chassis and Brake System Diagnosis	7 hours

Diagnostics of brakes - anti-lock brakes diagnostics - traction control diagnostics - steering and types diagnostics - Diagnostics on Tires - Instrumentation and infotainment systems.

Module:5	Advanced Diagnostic Techniques and Trends	8 hours

CAN, LIN, FlexRay, and Ethernet in diagnostics - Remote and cloud-based diagnostics - Predictive diagnostics using AI and machine learning - Cybersecurity in diagnostics - Introduction to ISO 26262 for diagnostic safety - Case studies: Real-time diagnosis of EVs and hybrids.

Module:6	Contemporary Issues	2 hours
	Total Lecture hours:	45 hours

Text Books

1.	William B. Ribbens, Understanding Automotive Electronics, 2017,7th Edition, Butterworth-Heinemann.
2.	Tom Denton, Automobile Electrical and Electronic Systems, 2020, 5th Edition, Routledge.

Reference Books

1.	Robert Bosch GmbH, Automotive Handbook, 2018,10th Edition, Wiley.
2.	Klaus Mollenhauer & Helmut Tschöke, Handbook of Diesel Engines,2010, Springer.
3.	Eric Chowanietz, Automotive Systems Engineering, 2016, SAE International.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT

Recommended by Board of Studies			
Approved by Academic Council	No.	Date	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Emission Control and Diagnostics**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			
		1.0			
Course Objectives					
1. Preparing the students to analyze automotive pollution control techniques 2. Examining Fuel Systems towards cleaner Fuels. 3. Applying ways to diagonise emission problems in Vehicles					
Course Outcomes					
1.Ascertain about the exhaust emissions from automobiles 2.Apply the global emission control standards and emission control systems 3.Examine fuel systems and their impact on vehicle emissions 4.Utilize the diagnostic procedures and exhaust gas measuring techniques					
Module:1	**Vehicle Emissions**				**7 hours**
Types of Vehicle Emissions & Air Pollution, Mechanisms of Pollutant Formation and Emission Factors, Environmental & Health Impact of Pollutants, Emission Control Strategies & After-Treatment Systems. Exhaust Emissions: Combustion products, Properties of exhaust gas components. Automotive Waste & End-of-Life Vehicle Management					
Module:2	**Emission Standards**				**10 hours**
Key regulatory standards: U.S. EPA Tier 3, California LEV III, Euro 6/7, and India BS-VI. Emission control legislation – I: Overview, CARB legislation, EPA legislation, EU legislation, Japanese legislation. Emission control legislation – II: US test cycles for passenger cars and light duty trucks, European test cycles for passenger cars and light duty trucks, Japanese test cycles for passenger cars and light duty trucks, test cycles for heavy commercial vehicles					
Module:3	**Emission Control Systems**				**9 hours**
Role of Control Devices: Crankcase Emission Control By PCV, Control of Exhaust Emissions using Vapour-Liquid Separator, Control of Exhaust Emission using Catalytic Converters and Stratified Charge Engine. Emission from Spark Ignition Engine and its Control, Emission from Compression Ignition Engine and its Control					
Module:4	**Fuel Systems**				**7 hours**
Engine Fuels, Small Engine Emissions, Role of Substitute Fuel, Role of Alternate Power Sources. Fuel Injection Systems and their Impact on Emissions. Cleaner Fuels and Electrification					
Module:5	**Diagnostic Procedures**				**10 hours**
Ways to diagonise emission problems in Vehicles: Using an OBD-II Scanner for Emissions Diagnostics, Functional Aspects of On-Board Diagnostic (OBD) Systems. Procedure for Conducting the Test for Durability of Emission Control Systems. Exhaust Gas Measuring Techniques: Exhaust gas test on chassis dynamometers, Exhaust gas measuring devices, Diesel smoke emission test, Evaporative emission test. Role of AI/ML in automotive emission control and smart diagnostics					
Module:6	**Contemporary Issues**				**2 hours**
	Total Lecture hours:				**45 hours**
Text Books					
1.	B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, 2017,2nd Edition, Narosa				
2.	James Halderman, Automotive Fuel and Emissions Control Systems, 2021,4th edition, Pearson				
Reference Books					
1.	John B. Heywood, Internal Combustion Engine Fundamentals, 2018, 2nd Edition, McGraw-Hill Education				

2.	G. Amba Prasad Rao, T. Karthikeya Sharma, Engine Emission Control Technologies, 2020, Apple Academic Press			
3.	Femina Patel, Sanjay Patel, Automotive Emissions and Its Control, 2012, LAP Lambert Academic Publishing			
4.	George Springer, Engine Emissions: Pollutant Formation and Measurement, 2012, Springer Science & Business Media			
5.	Avinash Kumar Agarwal, Jai Gopal Gupta, Nikhil Sharma, Akhilendra Pratap Singh, Advanced Engine Diagnostics, 2019, Springer-Verlag New York, LLC, Barnes & Noble.			
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT				
Recommended by Board of Studies				
Approved by Academic Council		**No.**	**Date**	

<table>
<tr><td>Course Code</td><td colspan="2">Course Title</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>XXXXXXXX</td><td colspan="2">Vehicle Safety Systems</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="2"></td><td colspan="4">Syllabus Version</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="4">1.0</td></tr>
<tr><td colspan="7">Course Objectives</td></tr>
<tr><td colspan="7">1.Explore suitable design practices to enable product improvement resulting in substantially less risk to Humans, Machines and the Environment
2.Familiarize Students in the design process of Vehicle Safety critical system in reducing system errors and faults.
3. Imparting the Students to gain knowledge on Vehicle Ergonomics and its developments.</td></tr>
<tr><td colspan="7">Course Outcomes</td></tr>
<tr><td colspan="7">1.Interpret the concepts of Vehicle Safety.
2.Illustrate the effects of Crashworthiness on Vehicle Design.
3.Demonstrate the various Safety Systems and its equipment.
4.Design and Examine concepts of Vehicle Ergonomics, performance measurements and evaluation methods.</td></tr>
<tr><td>Module:1</td><td colspan="2">Overview of Vehicle Safety</td><td colspan="4">6 hours</td></tr>
<tr><td colspan="7">Underlying principles,cause and effect,safety factors,design for uncertainty,identifying component safety factor,Digital models and man testing,compliance.
Braking Systems: Definitions, principles, design and components of Braking system,Brake-circuit configurations, Braking system design
Risk evaluation:Basic Triology,Decission models,Balancing risks.
Human Error control:Human error analysis,Illustrative errors,Acceptable error,Preventive measures, Standards: ISO262 262,ISO/PAS 8800:2024</td></tr>
<tr><td>Module:2</td><td colspan="2">Crashworthiness and its influence on Vehicle Design</td><td colspan="4">6 hours</td></tr>
<tr><td colspan="7">Introduction,Accident and injury analysis,Vehicle impacts:General Dynamics and Crush characteristics,Structural collapse and its influence upon Safety.
Noise Vibration and Harshness : Vibration fundamentals,Vibration control,Fundamentals of Acoustics,Human response to Sound,Automotive Noise sources and Control techniques.
Redefining Automotive Safety using AI/ML</td></tr>
<tr><td>Module:3</td><td colspan="2">Active and Passive Safety Systems</td><td colspan="4">12 hours</td></tr>
<tr><td colspan="7">Active Safety, Driving safety, Conditional safety, Perceptibility safety, Operating safety, Passive safety: Exterior safety,Interior safety, deformation behaviour of Vehicle body, Speed and Acceleration characteristics of Passenger compartment on impact.
Active Safety: Cruise control system, Lane departure warning, Tire Pressure Monitoring system, Electronic braking.
Passive Safety Equipments: Seat belt, regulations, Automatic Seat belt tightener system, collapsible Steering column, Tiltable Steering wheel, Air bags, Electronic system for activating Air bags, Bumper design for Safety.</td></tr>
<tr><td>Module:4</td><td colspan="2">Vehicle Ergonomics</td><td colspan="4">9 hours</td></tr>
<tr><td colspan="7">Automotive Ergonomics, Engineering Anthropometry and Biomechanics, Occupant Packaging, Driver Information Acquisition and Processing, Field of View from Automotive Vehicles.</td></tr>
<tr><td>Module:5</td><td colspan="2">Measurements, Modeling, and Research</td><td colspan="4">10 hours</td></tr>
<tr><td colspan="7">Modeling Driver Vision, Driver Performance Measurement, Driver Workload Measurement, Vehicle Evaluation Methods, Special Driver and User Populations,Future Research and New Technology Issues.</td></tr>
<tr><td>Module:6</td><td colspan="2">Contemporary Issues</td><td colspan="4">2 hours</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td></td><td colspan="2">Total Lecture hours:</td><td colspan="4">45 hours</td></tr>
</table>

Text Books	
1.	George A. Peters, Barbara J. Peters,Automotive Vehicle Safety,2019,1st Edition,CRC Press,London.
2.	Vivek D. Bhise, Ergonomics in the Automotive Design Process,2024,2nd Edition,CRC Press,UK.
Reference Books	
1.	Julian Happian-Smith,An Introduction to Modern Vehicle Design,2022,Butterworth-Heinemann, Reed Educational and Professional Publishing Ltd.
2.	Robert Bosch Gmbh,Automotive Handbook,2022,11th Edition,John Wiley and Sons,England.
3.	Prasad, Priya and Belwafa Jamel,Vehicles Crashworthiness and Occupant Protection,2017,American Iron and Steel Institute,USA.
4.	Daniel J Helt,Recent development in Automotive Safety Technology,2013,SAE International Publication.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Vehicle Bodies**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1.Familiarize the design, construction of vehicular bodies for passenger cars and commercial vehicles.
2.Providing an overview of lighting in vehicles
3.Enable the understanding of AI in Vehicle Body Engineering

Course Outcomes

1.Interpret the road-vehicle systematics and Vehicle bodies for passenger cars
2.Analyze the commercial vehicles bodies
3.Illustrate the external and internal lighting technologies
4.Investigate the automotive windshield, rear-window cleaning systems and AI in Vehicle Body Engineering

Module:1	Road-vehicle systematics and Vehicle bodies- passenger cars	9 hours

Road-vehicle systematics: Classification according to ECE, Classification according to USA, Types of Car body – Saloon, convertibles, Limousine, Estate Van, Racing and Sports car –car body terminology – Visibility- regulations, driver's visibility, improvement in visibility and tests for visibility, Vehicle bodies- passenger cars: Main dimensions, Body design, Aerodynamics, Aeroacoustics, Body structure, Body materials, Body surface, Body finishing components, Safety.

Module:2	Vehicle bodies-Commercial vehicles	7 hours

Types of commercial vehicle bodies – Light commercial vehicle body. Construction details of Flat platform body, Tipper body and Tanker body. Commercial vehicles, Light utility vans, Medium and heavy-duty trucks and tractor vehicles, Buses, Passive safety in commercial vehicles.

Module:3	Lighting Technology	10 hours

Functions, Regulations and equipment, Definitions and terms, Main headlamps - European System and regulations, Head lamps - USA system and regulations, Head lamps - Indian system and regulations, Headlamp cleaning systems, Fog lamps, Auxiliary driving lamps.
Lighting technology-II: Lights and lamps, Hazard-warning and turn-signal flashers, Side-marker, clearance, and tail lamps, Parking lamps, License-plate lamps, stop lamps, Rear fog warning lamps, reversing lamps, Daytime running lamps, other lighting devices, Motor-vehicle bulbs.

Module:4	Automotive Windshield, Window glass, Rear-window and Cleaning Systems	8 hours

Automotive windshield and window glass, the material properties of glass, Automotive glazing, Functional design glazing, Windshield wiper systems, Rear-window wiper systems, Headlamp cleaning systems, Wiper motors, Washing systems.

Module:5	AI in Vehicle Body Engineering	9 hours

Introduction to AI and machine learning concepts relevant to mechanical systems, Case study- AI-based generative design in body structures, Use of machine learning for crash simulation and impact analysis, Topology optimization using genetic algorithms and neural networks, Introduction to surrogate modeling for crash simulation, Example- AI for material behavior prediction in crashes, AI for Structural Health Monitoring (SHM)- sensors and data processing, Fault detection using supervised learning, Smart body panels and AI-enabled active materials, Predictive maintenance of vehicle body components using AI and IoT.

Module:6	Contemporary Issues	2 hours
	Total Lecture hours:	**45 hours**

Text Books	
1.	Bryan Morris, et al., Artificial Intelligence in Automotive Engineering, 2021, 1st Edition, Springer.UK.
2.	Robert Bosch, Automotive handbook, SAE publication 2022, 9th Edition, Germany.
Reference Books	
1.	Dieler Anselm, The passenger car body, SAE International, 2000,1st Edition, USA.
2.	Powloski, J., Vehicle Body Engineering, 1998. 2nd Edition. Business Books Ltd, USA.
3.	James E Duffy, Body Repair Technology for 4-Wheelers, 2009.1st Edition, Cengage Learning, USA.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Engine Peripherals**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1.Preparing the Students to understand Engine Peripherals connections and Vehicle Comfort system
2.Explore the basics of Body Control modules and other Engine Peripherals
3. Preparing to study and analyze Emission Control techniques

Course Outcomes

1.Dramatize the overview of Engine and Cooling System
2. Interpret the concepts of Vehicle Comfort and Convenience
3. Illustrate the Auxiliary Engine components and Turbochargers for IC Engines
4. Demonstrate on the Emission Control Systems

Module	Title	Hours
Module:1	**Overview of Engine and Cooling System**	**12 hours**
Motor vehicle system,Vehicle motion,Motion Vehicle dynamics,Vehicle aerodynamic,Vehicle Acoustics.Internal Combustion Engines-operation,components & types. Cooling:Water Cooling, Air Cooling, Intercooling, Oil and Fuel cooling, Cooling module technology, Intelligent Thermal management, Exhaust Gas cooling, Force feed lubrication system, Lubrication components.Air Filtering : Air Pollution, Air Filters		
Module:2	**Vehicle Comfort and Convenience**	**8 hours**
Passenger compartment Climate control : Climate control requirements,Climate control systems,Hybrid and Electric Vehicles,Cabin filters,Auxilary heater systems,power window systems and Sun roof systems,Electrical seat adjustment and Electrical steering wheel adjustment. Body Control Modules.		
Module:3	**Auxiliary Engine Components**	**6 hours**
HVAC, Alternator, Vacuum pump, Steering pump, Air intake system, Exhaust System		
Module:4	**Turbochargers and Superchargers for IC Engines**	**8 hours**
Superchargers (mechanical driven), Pressure wave, Exhaust Gas and Multistage Superchargers, Acceleration aids,Optimizing Turbocharger and Supercharger Performance using AI/ML,Recent developments		
Module:5	**Emission Control Systems**	**9 hours**
Exhaust Gas recirculation systems, Secondary Air injection, Evaporative Emission control system, Crankcase ventilation, Manifold, Catalytic converters, particulate converters, Muffers connecting elements,On-board Diagnostics,Use Cases.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	Robert Bosch Gmbh,Automotive Handbook,2022,11th Edition,John Wiley & Sons,Germany.
2.	James E. Duffy, Modern Automotive Technology Workbook,2025,9th Edition, Goodheart-Wilcox Publisher, USA.

Reference Books

1.	T.Kenneth Garrett,Kenneth Newton and William Steeds,The Motor Vehicle,2015,13th Edition, Butterworth-Heinemann Limited, London.
2.	Heinz Heisler,Advanced Vehicle Technology,2002,2nd Edition, Butterworth – Heinemann, New York.
3.	Robert Bosch Gmbh, Safety, Comfort and Convenience Systems,2016,7th Edition, Wiley–Blackwell, USA

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	Vehicle Security and Comfort Systems	3	0	0	3
Pre-requisite		Syllabus Version			
		1.0			

Course Objectives

1.Acquaint students with locking systems and theft-deterrent systems
2. Providing technical know-how of acoustic signaling devices and occupant-protection systems
3.Discussing about the Power-window drives, comfort and safety functions in the passenger compartment and driver assistance systems

Course Outcomes

1.Intrepret the locking systems & theft deterrent systems
2.Illustrate about the acoustic signaling devices.
3.Demonstrate the knowledge about occupant-protection systems and power window drives
4.Identify the technique for comfort and safety functions in the passenger compartment and Implement vehicle security and comfort systems

Module	Title	Hours
Module:1	**Locking systems**	**8 hours**
Function, structure, operating principle, Open by wire, Electrical locking system, Central locking system, Biometric Systems. Anti-theft systems, electronic vehicle immobilizers, functional description Comfort Entry/Go system		
Module:2	**Theft Deterrent systems**	**8 hours**
Regulations, Permissible alarm signals. System design, alarm detectors, Alarm system control unit, Alarm siren, Tilt sensor, Interior monitoring		
Module:3	**Acoustic signaling devices**	**8 hours**
Acoustic signalling devices applications, Horn, Fanfare horns, Noise control		
Module:4	**Occupant-protection systems and Power-window drives**	**9 hours**
Seat belts and seatbelt pretensioners, Front airbag, Side airbag, Components, Rollover protection systems, Active and automatic protection. Seat occupancy sensing. Power-window motors, Power-window control, Power sunroof drives		
Module:5	**Safety & Assistance Systems**	**10 hours**
Electrical seat adjustment, Electrical steering-column adjustment, Multi-purpose actuator, Critical driving situations, Causes of accidents and possible action, Applications, Convenience and safety functions, Sensors for all round electronic visibility, Sensor-data fusion. Smartphone connection, Radio and TV reception, Traffic telematics.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1.	William B. Ribbens, Understanding Automotive Electronics: An Engineering Perspective,2017,8th Edition, Butterworth-Heinemann Inc.
2.	Bosch, Safety, Comfort & Convenience Systems,2016, 7th Edition, Wiley–Blackwell.

Reference Books

1.	Bosch, Automotive Handbook, 2022,11th Edition, Wiley.
2.	Daniel Watzenig and Martin Horn, Automated Driving-Safer and More Efficient Future Driving,2017,1st Edition, Springer.
3.	Bosch, Automotive Electrics and Automotive Electronics- Systems and Components, Networking and Hybrid Drive, 2014,Springer.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	Automotive IoT	3	1	0	4
Pre-requisite	None	Syllabus Version			
		1.0			

Course Objectives

1. Acquaint students with the fundamentals of Automotive IoT and its role in the modern automotive ecosystem.
2. Familiarize learners with various vehicular communication systems and protocols employed in Automotive IoT.
3. Enable understanding of IoT-enabled connected vehicular technologies for sustainable mobility in smart cities, while providing insights into associated security concerns across diverse use cases.

Course Outcomes

1. Illustrate the basic concepts of Automotive IoT, vehicle connectivity types, and sensor roles in automotive systems.
2. Utilize different vehicular communication systems and network models for connected vehicle environments.
3. Apply smart mobility and in-vehicle computing methods to solve transport-related challenges.
4. Identify suitable methods to handle security risks and apply mitigation strategies in automotive systems.
5. Develop real-time IoT-based automotive applications and future-ready vehicle networks.

Module:1	Fundamentals of Automotive IoT	12 hours

Evolution of Transportation Models, Significance of IoT in Modern Automotive Systems, Layered IoT Architecture for Vehicles, Vehicular Connectivity and Networking- V2V, V2I, V2N, V2P, V2X , Smart Vehicles – Hardware in the Loop (HIL) - Embedded Sensors and Gateways for Automotive Ecosystem, Cloud for Vehicular Data Management.

Module:2	Vehicular Communication and Networking Technologies	12 hours

Vehicular Communication Systems, Wired Technologies- CAN, LIN, FlexRay, Wireless Technologies -Cellular vehicle to Everything, 4G/LTE, 5G NR based V2X, NFV, Software Defined Networking in Vehicular Environment, Real-Time Communication Protocols- Bluetooth, RTLS, LoRaWAN, MQTT, CoAP, Cluster Based Vehicular Networks – Active and Passive Clustering, Intelligent Clustering.

Module:3	Sustainable Mobility in Smart Cities	12 hours

Urban Transportation Inefficiencies, Vehicular Computing – Sensing and Data Acquisition, Mobility Management using IPV6, Mobility as a Service (MaaS), ADAS, AutoSAR for Sustainable Mobility, Efficiency Management- Start, Stop, Micro and Mild Hybrids, Infotainment, Intelligent Lane keep and Lane Change Algorithm, Tire Pressure Monitoring - Edge AI for Predictive Maintenence, Digital Twins for Connected Vehicles.

Module:4	Secure Vehicular Communication Systems	12 hours

Security Risks and Challenges for Connected Vehicles, Attack Vectors, Threat Modelling for Automotive Ecosystem, Mitigation Techniques for V2X, Authentication and Access Control, Cryptographic solutions for Automotive Security, Immobilizers, Trust-Based Information Framework, Automotive policies and Security Standards.

Module:5	Automotive IoT use cases	10 Hours

Next Generation Vehicular Networks, Vehicular Simulation Tools, Real-Time Automotive IoT Use Cases - Electronic Toll Collection, Automated Parking Reservation and Payment Systems, Intelligent Transportation System, Advanced Locomotives Using IoT, Remote Diagnostics, Stolen Vehicle Tracking and Recovery, Smart Navigation, Fleet Management and Predictive Analytics using Federated Learning.

Module:6	Contemporary Issues	2 hours

			Total Lecture Hours:	**60 Hours**
Text Books				
1.	Sidi Lu, Weisong Shi, Vehicle Computing from Traditional Transportation to Computing on Wheels, 2024, 1st Edition, Springer Nature, Germany.			
2.	Dennis Kengo Oka, Sharanukumar Nadahalli, Jeff Yost and Ram Prasad Bojanki, Building Secure Automotive IoT Applications, 2024, 1st Edition, Packt Publishing, UK.			
Reference Books				
1.	Kirsten Matheus and Michael Kaindl, Automotive High Speed Communication Technologies, 2024, 1st Edition, Science Direct, Netherlands.			
2.	Hussein T , Mouftah, Melike Erol and Sameh Sorour, Connected and Autonomous Vehicles in Smart Cities , 2023, 1st Edition, CRC Press, Routledge, USA.			
3.	Shiho Kim, Rakesh Shrestha, Automotive Cyber Security: Introduction, Challenges, and Standardization, 2020, 1st Edition, Springer, Singapore.			
4.	George Dimitrakopoulos, Current Technologies in Vehicular Communication, 2017, 1st Edition, Springer Nature, Switzerland.			
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT				
Recommended by Board of Studies				
Approved by Academic Council	**No.**	**Date**		

Course Code	Course Title	L	T	P	C
XXXXXXXX	Alternative Drives,Traction and Controls	3	0	0	3
Pre-requisite		Syllabus Version			
		1.0			

Course Objectives

1.Acquainting Students with the basics of propulsion using IC Engines and Electric Motors
2.Recognizing different Energy storage and conversion schemes for Hybrid Vehicles
3.Elaborate the different architectures for Hybrid Electric Vehicles

Course Outcomes

1.Interpret on Alternate Vehicle Technology and the difference in Electric Motors and IC Engines for propulsion in Automobiles
2.Illustarte the Charging systems for various Storages devices for Automobiles
3.Employ the parameters to select the various types of Motors used and control mechanism involved in Vehicles
4.Design of Hybrid Electric Vehicles with suitable architectures

Module:1	Overview of Alternate Vehicle Technology	8 hours

Background on need for alternate vehicle technologies for propulsion - Emissions from IC Engine based transportation and regulating standards - Projections on availability of nonrenewable energy sources - Alternate technologies for Vehicles for reducing urban pollution and for extending availability of resources – Configurations of Electric Vehicles-Importance of Hybrid Electric Vehicles technology-Standards for HEV : SAE & ISO Standards.

Module:2	Vehicle Propulsion	9 hours

Types of Motors and the Speed Torque characteristics,Components comprising traction torque – Vehicle movement and resistance – Dynamic equation - Tire–Ground Adhesion and Maximum Tractive Effort - Power Train Tractive Effort and Vehicle Speed- Vehicle performance – Operating Fuel economy in IC Engine Vehicles – Brake performance - Torque Speed characteristics of IC Engines – Electric Vehicles :Performance,Tractive effort in normal driving,Energy Consumption-Comparison of Electric Motors and IC Engines as Vehicle propulsion Power sources

Module:3	Energy Storage and Conversion	6 hours

Different types of Batteries for Electric vehicles - Lead acid batteries, Nickel Metal Hydride Batteries, Lithium ion batteries – Ultracapacitors, Ultra-High-Speed Flywheels,Comparison of different types of Batteries – Battery Management Systems and Energy Management Systems - Wireless Charging Systems – Fast Charging Systems - Super Capacitors - Fuel Cells – Control Strategy - Parametric Design - Solar Energy Converters.

Module:4	Motors and Controllers	8 hours

DC motors - Principle and control - Induction Motor drives - Methods of Speed control of Induction motor - Constant V / f control - Vector control method - Inverter for Vector control - Basic principles of BLDC Motors - Performance analysis and control of BLDC Motors - Sensor less technique for driving BLDC Motors - Regenerative braking with Electric drive - Four quadrant operation - Optimizing Energy recovery.

Module:5	Architectures for Hybrid Electric Vehicles	12 hours

Series, Parallel and Series Parallel Hybrids - Different architectures for Hybrid Electric Vehicles - Series Hybrid Electric Vehicle basics - Sizing of major components - Peak power sourcing - Parallel Hybrid Electric Vehicle basics - Engine on / off control strategy – Peak power sourcing - Drive train rating - Parallel Mild Hybrid Electric drive system – Series Parallel mild Hybrid Electric Vehicle system.

Design of Series Hybrid Drivetrain for Off-Road Vehicles, Powertrain Optimization,Case studies, Multiobjective Optimization Toolbox – Simulink

Module:6	Contemporary Issues	2 hours

	Total Lecture hours:		**45 hours**
Text Books			
1.	Mehrdad Ehsani,Yimin Gao,Sebatien Gay and Ali Emadi; Modern Electric, Hybrid Electric and Fuel Cell Vehicles,2019,3rd Edition,CRC Press,India.		
2.	Iqbal Husain, Electric and Hybrid Vehicles-Design Fundamentals,2021,3rd Edition,CRC Press,India.		
Reference Books			
1.	Mark L Quarto,Nicholas Goodnight,Light Duty Hybrid and Electric Vehicles,2023,1st Edition, Jones & Bartlett Learning.		
2.	Tom Denton,Hayley Pells,Electric and Hybrid Vehicles,2024,3rd Edition,Routledge.		
3.	Ronald K Jurgen,Electric and Hybrid-Electric Vehicles,2011,SAE International.		
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**AR/VR for Automotive Applications**	**3**	**0**	**0**	**3**
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives

1. Familiarize the concepts of Computer Graphics, VR systems, and Virtual Environment.
2. Explore the principles, technologies, and applications of Augmented Reality.
3. Apply Augmented and Virtual Reality for automotive applications, including integrating AI and digital twins.

Course Outcomes

1. Apply geometric modelling and 3D graphics techniques to build virtual environments.
2. Analyze the structure, functionality, and components of virtual and augmented reality systems.
3. Design and implement interactive animations and physical simulations in virtual environments.
4. Develop AR/VR-based solutions for automotive design, prototyping, and training, integrating AI and digital twin technologies.

Module:1	**Geometric Modelling and 3D Computer Graphics**	**8 hours**

Geometric modelling, 2D to 3D representations, 3D space curves, 3D Boundary Representation (B-Rep), frames of reference, modelling transformations, translation, rotation, scaling, instances, picking, flying, collision detection, virtual world space, positioning the virtual observer, perspective projection, stereo projection, human vision, 3D clipping, colour theory, real-time ray tracing in VR/AR environments.

Module:2	**Virtual Reality Systems and Technologies**	**9 hours**

Introduction to virtual reality, virtual environment requirements, benefits of VR, historical development of VR, scientific landmarks in VR, real-time computer graphics, flight simulation, virtual environment components, computer environment in VR, VR technology overview, interaction models, VR systems, sensor hardware, head-coupled displays, acoustic hardware, integrated VR systems, cloud and edge rendering for VR/AR, AI integration in VR systems, haptics and tactile feedback systems.

Module:3	**Animation and Physical Simulation in Virtual Environments**	**6 Hours**

Introduction to animation, dynamics of numbers, linear interpolation, non-linear interpolation, animation of objects, linear translation, non-linear translation, shape inbetweening, object inbetweening, free-form deformation, particle systems, gravitational simulations, rotating wheels, elastic collisions, projectile motion, simple pendulum, spring mechanics, aircraft flight dynamics.

Module:4	**Augmented Reality Systems and Applications**	**10 Hours**

Taxonomy of augmented reality, AR technologies, AR features, differences between AR and VR, challenges with AR, AR systems, AR functionality, augmented reality methods, visualization techniques in AR, enhancing interactivity in AR, evaluating AR systems, Mixed Reality (MR) and Extended Reality (XR), AI-powered AR systems, privacy, ethics, and data security in AR/VR environments.

Module:5	**Design, Prototyping, Manufacturing and Training using AR/VR**	**10 Hours**

Automotive design process, 3D concept development, VR-based collaborative design, virtual prototyping, modifying design concepts, overcoming physical modelling limitations, VR-based visualization, electronic system validation, AR in product development, AR-based remote assistance, AR-based component visualization, virtual assembly line optimization, AR-based retrofitting, immersive environments, VR-based digital training, simulation-based training, training cost reduction, improving learning outcomes, introduce open-source software such as ARToolKit, ARCore, Unity 3D, and Blender, etc., digital twins and industrial metaverse, Brain-Computer Interface (BCI) applications in VR, AI-driven personalization in training systems.

Module:6	**Contemporary Issues**	**2 hours**

		Total Lecture hours:	**45 hours**
Text Books			
1.	Ella Hassanien, Deepak Gupta, Ashish Khanna, Adam Slowik, Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications, 2022, Springer International Publishing.		
2.	Matthew Ball, The Metaverse: And How it Will Revolutionize Everything, 2022, 1st Edition, Liveright.		
Reference Books			
1.	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, 2013, Morgan Kaufmann.		
2.	John Vince, Virtual Reality Systems, 2007, Pearson Education Asia.		
3.	Adams, Visualizations of Virtual Reality, 2000, Tata McGraw Hill.		
4.	William R. Sherman, Alan B. Craig, Understanding Virtual Reality: Interface, Application and Design, 2008, Morgan Kaufmann.		
5.	Aukstakalnis S., Practical augmented reality: A guide to the technologies, applications, and human factors for AR and VR, 2016, Addison-Wesley Professional.		
6.	Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola Jr., Ivan Poupyrev, 3D User Interfaces: Theory and Practice, 2020, 2nd Edition, Addison-Wesley.		
7.	Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, 2016, 2nd Edition, Wiley Inter Science.		
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	Course Title	L	T	P	C
XXXXXXXX	**Soft Computing Techniques**	**3**	**1**	**0**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Enabling the students to apply fundamental concepts of machine learning, neural networks, optimization, and deep learning to solve real-world problems.
2. Enabling the students to acquire knowledge about data selection and classification.
3. Apply soft computing techniques to solve practical problems.

Course Outcomes

1. Apply the principles of soft computing, including fuzzy logic, fuzzy inference, and defuzzification, to solve practical problems.
2. Analyze the structure and learning methods of artificial neural networks to classify and recognize patterns.
3. Apply multilayer perception and genetic algorithm techniques to optimize real-world problem solving tasks.
4. Analyze hybrid soft computing systems and their applications in autonomous vehicles and intelligent transportation systems.
5. Apply optimization and hybrid soft computing techniques for solving data-driven and machine learning problems.

Module:1	Overview of Soft Computing and Fuzzy Logic	12 hours

Introduction to Soft Computing: Definition, characteristics, and comparison with hard computing. Components: Fuzzy Logic, Neural Networks, Genetic Algorithms, and Hybrid Systems. Fuzzy Sets: Introduction, membership functions, and basic operations. Fuzzy Relations and Inference: Fuzzy rules, propositions, implications, and inference mechanisms., Defuzzification Techniques: Methods and applications

Module:2	Artificial neural network	12 hours

Biological inspiration and historical context, Activation functions and their properties, Forward propagation and the role of weights and biases, McCulloch-Pitts Neuron, Perceptron, Training a single-layer neural network, Limitations of single-layer networks, Applications of single-layer neural network. Artificial Neuron Models: Perceptron, Adaline, and their learning rules. Self-Organizing Maps (SOMs): Introduction and applications. Applications of ANNs: Pattern recognition, classification, and prediction tasks.

Module:3	Neural network and Optimization	12 hours

Introduction to Multilayer Perceptron (MLP), Backpropagation algorithm for training MLPs, Stochastic Gradient Descent algorithm and weight optimization techniques, Hyperparameter tuning in MLPs, Applications of MLP.
Introduction to Genetic algorithms, Biological Background, Traditional Optimization and Search Techniques, Genetic Algorithm and Search Space, Operators in Genetic Algorithm, Stopping Conditions for Genetic Algorithm Flow, Problem Solving Using Genetic Algorithm: Maximizing a Function
GA Operators: Detailed study of selection strategies, crossover techniques, and mutation methods. Applications of GAs: Optimization problems, scheduling, and design.

Module:4	Advanced Optimization and Hybrid Approaches in Soft Computing Paradigms	12 hours

Overview of optimization in soft computing, Basic Evolutionary Processes, Evolutionary Systems as Problem Solvers, Canonical Evolutionary Algorithms - Evolutionary Programming, Evolution Strategies, A Unified View of Simple EAs, Population Size. Applications of Optimization in Soft Computing: Feature selection and dimensionality reduction, Data clustering and classification

Neuro-Fuzzy Systems: Integration of neural networks and fuzzy logic. Fuzzy-Genetic Systems: Combining fuzzy logic with genetic algorithms for enhanced performance. Rough Set Theory: Introduction, approximation spaces, and applications in data analysis.		
Module:5	**Soft Computing Applications in Autonomous Vehicles and Intelligent Transportation Systems**	**10 hours**
Soft computing applications in autonomous vehicles, including path planning and control; intelligent transportation systems for traffic management; vehicle dynamics optimization; predictive maintenance using sensor data; data clustering for driving pattern analysis; and feature selection for performance enhancement.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Books

1.	Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, Machine Learning: Algorithms and Applications, 2016, 1st Edition, CRC Press, USA
2.	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016, 1st Edition, MIT Press, USA.

Reference Books

1.	Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, 2020, 1st Edition, Cambridge University Press, UK.
2.	Oswald Campesato, Artificial Intelligence, Machine Learning, and Deep Learning, 2020, 1st Edition, Mercury Learning & Information, USA.
3.	Lakhmi C. Jain, Marko J. M. Hossain, Soft Computing for Intelligent Systems, 2003, 1st Edition, Springer, Germany.
4.	Mohamed K. Hassan, Syed Zulqarnain Shah, Artificial Intelligence for Autonomous Vehicles: Road to Autonomous Driving, 2021, 1st Edition, Wiley-IEEE Press, USA.
5.	Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 2019, 2nd Edition, O'Reilly Media, USA.
6.	S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, 2018, 3rd Edition, Wiley India, India.

Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	