ANNA UNIVERSITY, CHENNAI

NON- AUTONOMOUS COLLEGES

AFFILIATED TO ANNA UNIVERSITY

M.E. AUTOMOBILE ENGINEERING

REGULATIONS 2025

PROGRAMME OUTCOMES (POs):

PO	Programme 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. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO	Programme Specific Outcomes
PSO1	Graduates will apply advanced engineering principles, computational tools, and modern software to design, analyze, and optimize automotive systems and components. They will develop innovative and sustainable solutions that address complex challenges in the automotive sector, integrating safety, environmental impact, and ethical responsibility.
PSO2	Graduates will demonstrate strong communication, leadership, and teamwork skills, and will actively engage in lifelong learning to stay current with technological advancements. They will contribute effectively to multidisciplinary teams and uphold professional and ethical standards in their engineering practice.

ANNA UNIVERSITY, CHENNAI

POSTGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E., Automobile Engineering **Regulations:** 2025

Abbreviations:

BS –Basic Science (Mathematics)

ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**) & Emerging Technology (**ET**))

SD – Skill Development

SL – Self Learning

TCP –Total Contact Period(s)

L –Laboratory Course

T – Theory

LIT –Laboratory Integrated Theory

PW – Project Work

Semester – I

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	MA25C06	Applied Mathematical and Statistical Modelling	T	3	1	0	4	4	BS
2.	AM25101	Electric and Hybrid Vehicle Technology	T	3	0	0	3	3	ES (PC)
3.	AM25102	Vehicle Body Engineering and Ergonomics	T	3	0	0	3	3	ES (PC)
4.	AM25103	Automotive Engine and Pollution Control	T	4	0	0	4	4	ES (PC)
5.	AM25104	Automotive Chassis and Drivetrain Systems	LIT	3	0	2	5	4	ES (PC)
6.	AM25105	Technical Seminar	-	0	0	2	2	1	SD
						Total	**21**	**19**	

Semester – II

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	AM25201	Automotive Design and Simulation	T	3	0	0	3	3	ES (PC)
2.		Programme Elective I	T	3	0	0	3	3	ES (PE)
3.		Programme Elective II	T	3	0	0	3	3	ES (PE)
4.	AM25202	Vehicle Dynamics and Control	LIT	3	0	2	5	4	ES (PC)
5.	AM25203	Engine and Vehicle Testing Laboratory	L	0	0	4	4	2	ES (PC)
6.		Industry-Oriented Course I	-	1	0	0	1	1	SD
7.	AM25204	Industrial Training	-	-	-	-	-	2	SD
8.		Self-Learning Course	-	-	-	-	-	1	-
						Total	**19**	**19**	

Semester – III

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Programme Elective III	T	3	0	0	3	3	ES (PE)
2.		Programme Elective IV	T	3	0	0	3	3	ES (PE)
3.		Programme Elective V	T	3	0	0	3	3	ES (PE)
4.		Industry-Oriented Course II	--	1	0	0	1	1	SD
5.	AM25301	Project Work I	-	0	0	12	12	6	SD
						Total	**22**	**16**	

Semester – IV

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	AM25401	Project Work II	-	0	0	24	24	12	SD
						Total	**24**	**12**	

PROGRAMME ELECTIVE COURSES (PE)

S. No.	Course Code	Course Title	Periods per week			Total Contact Periods	Credits
			L	T	P		
1.	AM25001	Alternative Fuels and Propulsion Systems	3	0	0	3	3
2.	AM25002	Autonomous and Connected Vehicles	3	0	0	3	3
3.	AM25003	Automotive regulations	3	0	0	3	3
4.	AM25004	Engine Combustion Thermodynamics and Engine Heat Transfer	3	0	0	3	3
5.	AM25005	Green Vehicle Technology	3	0	0	3	3
6.	AM25006	IC Engine Process Modelling	3	0	0	3	3
7.	AM25007	Advanced Automotive Electronics	3	0	0	3	3
8.	AM25008	Automotive Embedded Systems	3	0	0	3	3
9.	AM25009	Automotive Instrumentation and Testing	3	0	0	3	3
10.	AM25010	Automotive Mechatronics	3	0	0	3	3
11.	AM25011	Automotive Safety Systems	3	0	0	3	3
12.	AM25012	Vehicle Electrical and Electronics System	3	0	0	3	3
13.	AM25013	Application of AI and DS in Automotive Systems	3	0	0	3	3
14.	AM25014	Automotive Materials and Manufacturing	3	0	0	3	3
15.	AM25015	Motorsport Technology	3	0	0	3	3
16.	AM25016	Noise, Vibration, and Harshness (NVH)	3	0	0	3	3
17.	AM25017	Reverse Engineering in Automobile Engineering	3	0	0	3	3
18.	AM25018	Special Vehicles	3	0	0	3	3
19.	AM25019	Sustainable Automotive Technologies	3	0	0	3	3
20.	AM25020	Vehicle Internet of Things	3	0	0	3	3

Semester I

MA25C06	Applied Mathematical and Statistical Modelling	L	T	P	C
		3	1	0	4

Course Objectives:

- To equip students with advanced mathematical techniques, specifically Fourier Transforms, for formulating and solving partial differential equations that model fundamental mechanical engineering phenomena such as heat transfer, vibrations, and fluid flow.
- To provide a strong foundation in statistical inference, enabling students to estimate population parameters (like material properties and process capabilities) from experimental data and assess the quality and reliability of these estimators.
- To enable students to design efficient, structured experiments and apply appropriate statistical tests to make valid, data-driven decisions for comparing processes, optimizing designs, and solving complex engineering problems.

Fourier Transform: Definitions, Properties, Transform of elementary functions, Dirac delta function, Convolution theorem, Parseval's identity, Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poison's equations.

Estimation Theory: Unbiasedness, Consistency, Efficiency and sufficiency, Maximum likelihood estimation, Method of moments.

Testing of Hypothesis: Sampling distributions, Small and large samples, Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions, Analysis of r x c tables, Goodness of fit, independent of attributes.

Design of Experiments: Analysis of variance, One way and two-way classifications, Completely randomized design, Randomized block design, Latin square design, 2^2 Factorial design.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

References:

1. Andrews, L. C., & Shivamoggi, B. K. (2003). Integral transforms for engineers. Prentice Hall of India.
2. Devore, J. L. (2014). Probability and statistics for engineering and the sciences, Cengage Learning.
3. Johnson, R. A., Miller, I., & Freund, J. (2015). Miller and Freund's probability and statistics for engineers, Pearson Education Asia.

E-resources:

1. https://www.edx.org/learn/probability-and-statistics/massachusetts-institute-of-technology-probability-the-science-of-uncertainty-and-data
2. https://www.itl.nist.gov/div898/handbook/
3. https://ocw.mit.edu/courses/2-830j-control-of-manufacturing-processes-sma-6303-spring-2008

AM25101	Electric and Hybrid Vehicle Technology	L	T	P	C
		3	0	0	3

Course Objectives:

To equip students with advanced knowledge of electric and hybrid vehicle systems, including propulsion design, control strategies, modelling, simulation, and integration of power electronics, energy storage, and emerging technologies in mobility.

Architectures of Electric and Hybrid Vehicles: classification of EV, HEV, PHEV, FCEV architectures, System-level design considerations, Multimode hybrid configurations: power split, series-parallel with torque coupling, Vehicle dynamics and system integration, Case studies: Tesla, Toyota Prius, BMW i-Series.

Activity: Case Study on EV/HEV Architectures / Flipped Classroom on Multimode Hybrid Configurations

Battery and Energy Storage System Design: Electrochemical modelling of Lithium-ion batteries, Battery pack design, BMS algorithms (SoC, SoH estimation), Cell balancing methods: passive vs. active. Thermal analysis and thermal management systems, Fuel cell technologies: PEMFC, DMFC; integration in FCEVs, Hybrid energy storage systems (HESS)

Activity: Software Analysis of Battery Pack Design / Assignment on BMS Algorithms and Cell Balancing

Motor and Motor Drive Control: Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, Switched Reluctance motors, BLDC. High-efficiency converter topologies for traction applications, Control of bidirectional converters, inverter modulation (SPWM, SVPWM), Advanced motor drives: PMSM, SRM, Induction Machines – vector and direct torque control, Torque-speed control with regenerative braking, EMI/EMC considerations in EV powertrains.

Activity: Virtual Demonstration of Motor Control Techniques / Problem Set on Torque-Speed Characteristics

Vehicle Control Strategies and Modelling: Control architecture of EV/HEV: supervisory control, ECU integration, Energy and power management algorithms: Rule-based, Optimisation-based Modelling of EV systems using system engineering software, State machine and control logics, Hardware-in-the-loop (HIL) for validation.

Activity: Simulation Project on Supervisory Control / Quiz on ECU Integration and Control Architectures

Testing, Standards, and Future Technologies: Vehicle-level testing: performance, range, NVH, thermal Testing standards: AIS, ISO, SAE (J2954, J1772, J2344), Charging standards (IEC 61851, CHAdeMO, CCS, GB/T),Smart charging, V2G, battery swapping systems - Emerging areas: AI in EV control, solid-state batteries, autonomous EVs, L5 electrification.

Activity: Group Assignment on EV Testing Standards / Presentation on Emerging EV Technologies
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)
References: 1. Ehsani, M., Gao, Y., Longo, S., &Ebrahimi, K. (2018). Modern electric, hybrid electric, and fuel cell vehicles: Fundamentals, theory, and design (3rd ed.). CRC Press. 2. Husain, I. (2011). Electric and hybrid vehicles: Design fundamentals (2nd ed.). CRC Press. 3. Mi, C., Masrur, M. A., & Gao, D. W. (2011). Hybrid electric vehicles: Principles and applications with practical perspectives. Wiley-IEEE Press. 4. Hayes, J. G., &Goodarzi, G. A. (2018). Electric powertrain: Energy systems, power electronics, and drives for hybrid, electric, and fuel cell vehicles. Wiley. 5. Khaligh, A., & Li, Z. (2010). Battery, ultracapacitor, fuel cell, and hybrid energy storage systems for electric, hybrid electric, and plug-in hybrid electric vehicles. IEEE Transactions on Industrial Electronics, 57(11), 3873–3884. https://doi.org/10.1109/TIE.2010.2044653
E-Resources: https://www.classcentral.com/course/swayam-electric-vehicles-458436 https://www.classcentral.com/course/swayam-introduction-to-electric-and-hybrid-electric-vehicle-292692 https://www.mathworks.com/matlabcentral/fileexchange/72865-design-and-test-lithium-ion-battery-management-algorithms https://in.mathworks.com/videos/designing-battery-systems-with-modeling-and-simulation-1593688433886.html https://www.comsol.com/support/learning-center/article/39341 https://in.mathworks.com/discovery/battery-models.html https://wizape.com/English/Electric-and-Hybrid-Vehicles-Overview https://www.udemy.com/course/hybrid-and-electric-vehicle-for-beginners-full-course-2021/

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Classify and analyze various electric and hybrid vehicle architectures (EV, HEV, PHEV, FCEV) and evaluate system-level design through case studies.	PO1 (2), PO3 (3)	3	2
CO2	Design and simulate battery and energy storage systems, including lithium-ion models, BMS algorithms, and fuel cell integration, and assess thermal management strategies.	PO1 (3), PO2 (2), PO3 (3)	3	1
CO3	Select and implement appropriate motor types and drive control techniques, and demonstrate converter efficiency, modulation methods, and regenerative braking control.	PO1 (3), PO2 (1), PO3 (3)	3	2
CO4	Develop and validate vehicle control strategies using modeling tools and HIL testing, and apply relevant standards and emerging technologies in EV systems.	PO1 (3), PO2 (2), PO3 (3)	3	2

AM25102	Vehicle Body Engineering and Ergonomics	L	T	P	C
		3	0	0	3

Course Objectives:

To enable students to critically analyse and design vehicle body structures by integrating advanced concepts of aerodynamics, structural optimization, ergonomic modelling, and regulatory compliance. Emphasis is placed on research-driven innovation and simulation tools for passenger and commercial vehicle body development.

Advanced Car Body Design and Safety Engineering: Classification and evolution of car body types (sedans, coupes, limousines, sports cars, etc.), Body-in-white (BIW) development: load paths and crashworthiness. Structural layout and modularity in body panels, Safety design strategies: crash energy management, crumple zones, intrusion resistance, Driver visibility standards, simulations, and regulatory frameworks, Digital human modelling for seat design, Lightweighting: advanced body materials and joining techniques

Activity: Case Study on Crashworthiness / Software Analysis of Driver Visibility

Bus Body and Chassis Integration: Design considerations based on passenger capacity and operational requirements, Layout planning for low-floor/high-floor buses: accessibility, NVH, and structural integrity Integral vs. conventional construction: implications on ride and durability, Material selection for long-term fatigue and corrosion resistance, Simulation of load distribution and torsional stiffness, Case studies: optimization of engine placement, structural layout for electric buses

Activity: Problem-Based Assignment on Low-Floor Bus Layout Planning / Simulation Activity on Torsional Stiffness and Load Distribution

Commercial Vehicle Body Systems and Ergonomics: Design and analysis of commercial body types: tippers, tankers, platforms, refrigerated vehicles, Finite element analysis of frame-mounted structures. Ergonomic principles in cab design: driver posture, reach, visibility, comfort Integration of HVAC, display interfaces, and vibration isolation. Advanced materials for load-carrying efficiency and lifecycle cost reduction, Regulations for over-dimensional and hazardous material transport

Activity: Software Analysis of Frame-Mounted Structures / Assignment on Ergonomic Cab Design and Interface Integration

Vehicle Aerodynamics and Computational Fluid Dynamics: Drag components: form, skin friction, interference, induced drag, Influence of body shape on lift, side force, and yaw moment. Flow separation and vortex management techniques, Design optimization for fuel economy and high-speed stability, Wind tunnel correlation and virtual testing: 1D/3D CFD validation. Use of simulation tools.

Activity: CFD Simulation of Drag Components and Flow Separation / Virtual Demonstration of Wind Tunnel Correlation

Human Factors, Styling, and Digital Ergonomics: Ergonomic modelling using software, Anthropometric databases and their application in occupant packaging, Cognitive ergonomics: HMI, visibility cone, control accessibility, Styling workflow: clay modelling to digital sculpting. Case study: ergonomic audit of existing vehicle models, Sustainable design: impact of ergonomics on mobility inclusion.

Activity: Software-Based Ergonomic Modelling and Occupant Packaging / Case Study on Ergonomic Audit of Existing Vehicle Models

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Fenton, J. (1992). Vehicle body layout and analysis. Mechanical Engineering Publications Ltd.
2. Anselm, D. (2000). The passenger car body. SAE International.
3. Birch, J. (2011). Motor vehicle body design. Butterworth-Heinemann.
4. Allen, B. (n.d.). Vehicle aerodynamics. SAE Technical Papers and Journals.
5. Happian-Smith, J. (2002). An introduction to modern vehicle design. Butterworth-Heinemann.
6. Bhise, V. D. (2016). Ergonomics in the automotive design process. CRC Press.

E-Resources:

https://archive.org/details/vehiclebodylayou0000fent
https://www.routledge.com/Ergonomics-in-the-Automotive-Design-Process/Bhise/p/book/9781482224145
https://www.researchgate.net/publication/327185994_Ergonomics_in_the_Automotive_Design_Process
https://designstudiopress.com/product/h-point/
https://www.nasa.gov/sites/default/files/atoms/files/human_integration_design_handbook.pdf
https://www.nhtsa.gov/crash-simulation-vehicle-models
https://www.iitk.ac.in/erl/ais/ais-052.pdf
https://www.routledge.com/Heavy-Vehicle-Ergonomics/Hemphill/p/book/9780415279224
https://www.fmcsa.dot.gov/research-and-analysis/research/human-factors-considerations-truck-cab-design
https://morth.nic.in/transportation-of-hazardous-goods
https://www.openfoam.com/documentation/user-guide
https://onlinecourses.nptel.ac.in/noc19_de01/preview
https://www.plm.automation.siemens.com/global/en/products/tecnomatix/jack.html
https://dined.io.tudelft.nl/en
https://help.autodesk.com/view/ALIAS/2024/EN

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Classify car and bus body types and evaluate structural layouts for crashworthiness and modularity using case studies and simulations.	PO1 (2), PO3 (3)	3	2
CO2	Design commercial vehicle body systems and analyse ergonomic features using digital modelling tools and anthropometric data.	PO1 (3), PO2 (2), PO3 (3)	3	2
CO3	Apply CFD tools to simulate and optimize vehicle aerodynamics for drag reduction, fuel efficiency, and high-speed stability.	PO1 (3), PO2 (2), PO3 (3)	3	2
CO4	Assess safety and regulatory standards in vehicle design and demonstrate integration of lightweight materials and joining techniques.	PO1 (3), PO2 (2), PO3 (3)	3	2

AM25103	Automotive Engine and Pollution Control	L	T	P	C
		4	0	0	4

Course Objectives:

This course aims to provide comprehensive knowledge on sources and effects of automotive pollution and emission standards It equips students with an understanding on the formation of major pollutants in spark ignition engines and Compression ignition engines. The course also emphasizes working principle of emission measuring instruments and test procedures.

Emission From Automobiles

Basic engine theory - Engine design and operating parameters – Typical Performance Curves and Emission Curves, Sources of Pollution, Automobile Fleet Stats - Various emissions from Automobiles — Regulated and Non-regulated Emissions — Effects of pollutants on environment and human health – Evaluation of emission standards. Lubricants handling and harmful discharges. Introduction to Global Warming, Carbon Balancing and Cycles, CO_2 emission, carbon capturing, Introduction to Electro Magnetic Emissions, and Functional Safety of emission control devices. Student review presentation on an energy report.

Activity: Case Study on Emission Standards and Fleet Statistics / Student Review Presentation on Global Energy or Emission Report

SI Engine, Combustion, Emissions Formation

SI engines - Stages of combustion - Abnormal Combustion, Theories of Detonation, Effect of operating variables on Combustion and Emission Formation in SI Engines - Carbon Monoxide - Unburned hydrocarbon, NOx, Smoke, Aldehyde emissions - Effects of design and operating variables on emission formation, Advances in SI engines, GDI – TGDI - LTC – HCCI, a literature-based comparative study on combustion and emission formation.

Activity: Literature-Based Comparative Study on Advanced SI Combustion Techniques / Quiz on Emission Formation Mechanisms in SI Engines

CI Engine, Combustion, Emission Formation

CI engines - Stages of combustion - Diesel Knock, Droplet and Spray Characteristics, Effect of operating variables on Combustion and Formation of White, Blue, and Black Smokes, NOx, soot, Sulphur particulate and intermediate Compounds – Physical and Chemical delay — Significance Effect of operating variables on Emission Formation - Cetane number Effect. Advances in CI engines – CRDI – VVT – LTC in Diesel – RCCI – Dual Fuel – Early injection strategies. A literature-based comparative study on combustion and emission formation.

Activity: Assignment on Diesel Combustion and Emission Formation / Literature-Based Comparative Study on Advanced CI Engine Technologies

Pollution Control Technologies

Controlling of pollutants - Catalytic converters, types of substrates and catalysts, Low temperature catalyst and activation — Charcoal Canister — Positive Crank case ventilation system, Secondary air injection, Thermal reactor, Laser Assisted Combustion. CO2 control techniques, Pre, Post and Oxy fuel combustion, Absorption, Adsorption and membrane separation. Fumigation, EGR, HCCI, Turbo charger, Particulate Traps, Re-generation methods, SCR, LNT, ASC.

Activity: Virtual Demonstration of Emission Control Devices / Assignment on CO_2 Control Techniques and Carbon Capture

Test Procedures and Emission Measurements

Constant Volume Sampling I and 3 (CVSI &CVS3) Systems- Sampling Procedures — Chassis dyno – Transient dyno, seven mode and thirteen mode cycles for Emission Sampling — Sampling problems — Emission analysers —NDIR, FID, Chemiluminescent, Smoke meters, Dilution Tunnel for PM measurement and Laser scattering method for PN measurement, SHED Test, Sound level meters. Homologation, EMC/EMI testing of electric electronic devices. On-board pollution measurement equipment (PEMS). Emission regulations for off-road vehicles, TREM norms.

Activity: Software Analysis of Emission Sampling and Measurement Techniques / Case Study on On-Board Emission Measurement (PEMS) and Homologation

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Springer, G. P., & Patterson, D. J. (1986). Engine emissions: Pollutant formation. Plenum Press.
2. Patterson, D. J., &Henin, N. A. (1985). Emission from combustion engine and their control. Ann Arbor Science Publication.
3. Pundir, B. P. (2017). Engine emissions (2nd ed.). Narosa Publications.
4. Ganesan, V. (2005). Internal combustion engines (8th reprint). Tata McGraw Hill Book Co.
5. Crouse, R. H., & Anglin, D. L. (1993). Automotive emission control. McGraw Hill.
6. Leberanek, L. (1993). Noise reduction. McGraw Hill.
7. Duerson, C. (1990). Noise abatement. Butterworths Ltd.
8. Alexander, A., Barde, J. P., Lomure, C., & Langdan, F. J. (1987). Road traffic noise. Applied Science Publishers Ltd.

E-Resources:

https://www.youtube.com/watch?v=V83pI7WbSpM

https://www.youtube.com/watch?v=ciCWXWR9SFw

https://www.youtube.com/watch?v=PPJjNY9cNuI

https://www.youtube.com/watch?v=e6rglsLy1Ys

https://www.youtube.com/watch?v=xL6x3sqH9QU

https://www.youtube.com/watch?v=foYggZIQevM https://www.youtube.com/watch?v=Y8l6AEquy94 https://www.youtube.com/watch?v=iEkcG7uzr_Y https://www.youtube.com/watch?v=xTNnJiXXMro https://www.youtube.com/watch?v=8Q5TRYik_jQ https://www.youtube.com/watch?v=DW06y-H5qo0 https://www.youtube.com/watch?v=J9TfNksMIW4 https://www.youtube.com/watch?v=o8WcP97md_w

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Analyse emission characteristics of SI and CI engines and compare the effects of combustion variables on pollutant formation.	PO1 (3), PO3 (3)	3	1
CO2	Evaluate pollution control technologies such as catalytic converters, EGR, and particulate traps for their effectiveness in reducing emissions.	PO1 (3), PO2 (2), PO3 (3)	3	2
CO3	Apply emission measurement techniques using equipment like NDIR, FID, and CVS systems, and interpret results based on regulatory standards.	PO1 (3), PO2 (3), PO3 (3)	3	2
CO4	Assess the environmental impact of automotive emissions and demonstrate understanding of global warming, carbon cycles, and functional safety.	PO1 (3), PO2 (2), PO3 (3)	3	2

AM25104	Automotive Chassis and Drivetrain Systems	L	T	P	C
		3	0	2	4

Course Objective:
This course aims to provide a comprehensive understanding of the design, function, and integration of chassis systems and drivetrain components in automobiles. It covers frames, suspension, steering, braking systems, clutches, gearboxes, and advanced transmission technologies with an emphasis on system behaviour, safety, and emerging technologies.

Chassis Fundamentals and Steering Systems: Chassis layout types based on Power plant location and drive types, Types and construction of frames, materials, and load considerations, Front axles, stub axles, and wheel geometry, True rolling condition, Ackermann and Davis steering, Steering errors, linkages, steering gears, slip angle, oversteer/understeer, EPAS.

Activity: Virtual Demonstration of Steering Geometry and Ackermann Principle / Assignment on Chassis Layout and Frame Design

Practical: Chassis layout case studies, Steering gear disassembly and study, Power-assisted steering system demonstration

Clutch and Gearbox Systems: Requirement of transmission system, Types of transmission system, Requirement of Clutches, Functions-Types of clutches, construction and operation of Single plate, multiplate and Diaphragm Spring clutches. Centrifugal clutch, DCT, Electronic clutch. Purpose of gear box. Construction and working principle of sliding, constant and synchromesh gear boxes, Automatic manual transmission. Introduction to epicycle gear trains, Numerical examples on performance of automobile such as Resistance to motion, Tractive effort, Engine speed & power and acceleration. Determination of gear ratios for different vehicle applications.

Activity: Problem Set on Gear Ratio Calculation and Vehicle Performance / Case Study on Modern Transmission Systems (DCT, AMT, Epicyclic)

Practical: Single plate clutch disassembly, Gearbox component study and reassembly.

Propeller Shaft, Axles, and Differential: Effect of Driving Thrust, torque reactions and side thrust, Hotchkiss drive, torque tube drive, radius rods and stabilizers, Propeller Shaft, Universal Joints, Constant Velocity Universal Joints. Construction and Design of Drive Axles, Types of Loads acting on drive axles, Full, Floating, Three, Quarter Floating and Semi, Floating Axles, Axle Housings and Types. Front Wheel drive, Final drive, different types, Double reduction and twin speed final drives, Differential principle and types, limited speed differential.

Activity: Assignment on Axle Design and Load Analysis / Virtual Demonstration of Differential Operation and Final Drive Types

Practical: CV joint dismantling, Differential and rear axle assembly

Braking and Advanced Transmission Systems: Braking theory, stopping distance, weight transfer, Drum and disc brake mechanisms and efficiency, Hydraulic, mechanical, pneumatic, and ABS systems, Hydrodynamic drives: fluid coupling, torque converters, Hydrostatic drives and Janny drive system, CVT, AMT, electric drives, Ward Leonard control

Activity: Case Study on ABS and Brake Efficiency / Assignment on Hydrodynamic and Electric Drive Systems

Practical: Brake system demonstration (ABS/regenerative braking), Torque converter and AMT disassembly, Epicyclic gear assembly study

Suspension and Tyre Systems

Need for suspension, ride comfort and stability, Leaf, coil, torsion bar, rubber, pneumatic, hydro-elastic springs, independent suspension, telescopic shock absorbers, Air suspension system. Types and Constructional Details of Different Types of Wheels and Rims, Different Types of Tyres and their constructional details.

Activity: Virtual Demonstration of Suspension Types and Ride Comfort / Assignment on Tyre Construction and Performance

Practical: Study of conventional vs modern suspension, Case study on active suspension systems, Tyre inspection and comparison

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References

1. Heisler, H. (2020). Advanced vehicle technology. Butterworth-Heinemann.
2. Singh, K. (2022). Automobile engineering. Standard Publishers.
3. Erjavec, J. (2020). Automotive technology: Principles, diagnosis, and service. Cengage.
4. Halderman, D., & James, K. V. (2013). Automotive chassis systems. Prentice Hall.
5. Duffy, J. E. (2011). Modern automotive technology. Goodheart-Willcox.
6. Husain, I. (n.d.). Electric and hybrid vehicles: Design fundamentals. CRC Press..

E-Resources:

https://www.classcentral.com/course/engineering-tsinghua-university-automobile-chassi-284886
https://catalogue.surrey.ac.uk/2024-5/module/ENG2119
https://www.riseupp.com/course/tsinghua-university/automotive-chassis-systems-and-design
https://www.amrita.edu/course/automotive-chassis-and-transmission-systems
https://link.springer.com/book/10.1007/978-3-319-72437-9
https://link.springer.com/book/10.1007/978-3-8348-9789-3
https://www.engbookpdf.com/2019/04/automotive-engineering-powertrain.html

https://en.wikipedia.org/wiki/Drivetrain
https://en.wikipedia.org/wiki/Drive_by_wire
https://en.wikipedia.org/wiki/Electronic_stability_control

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Identify and compare chassis layouts, frame types, and steering geometries, and demonstrate understanding through practical disassembly and analysis.	PO1 (2), PO3 (3)	3	2
CO2	Explain and evaluate clutch and gearbox mechanisms, including manual and automatic systems, and calculate gear ratios for various vehicle applications.	PO1 (3), PO2 (2), PO3 (3)	3	2
CO3	Analyse the design and function of propeller shafts, axles, and differentials, and demonstrate assembly and inspection procedures.	PO1 (3), PO2 (2), PO3 (3)	3	2
CO4	Assess braking, suspension, and tyre systems for performance and comfort, and apply knowledge in practical demonstrations and case studies.	PO1 (3), PO2 (2), PO3 (3)	3	2

Semester II

AM25201	Automotive Design and Simulation	L	T	P	C
		3	0	0	3

Course Objectives:

This course develops proficiency in designing and simulating complex automotive systems. Students gain hands-on experience with advanced CAD/CAE tools and are prepared to tackle future challenges in vehicle innovation and sustainability.

Engine Component Design and Simulation

Material selection for cylinder, piston, and connecting rod using simulation-based optimization. Design and analysis of Cylinder geometry and thermal stresses, Piston assembly: piston, rings, pin, Connecting rod under dynamic loading.

Powertrain Dynamics and Valve Mechanisms

Crankshaft design under bending and torsional loads. Simulation of crankshaft fatigue and vibration. Design and modeling of Inlet and exhaust valves. Camshaft and rocker arm mechanisms.

Transmission Systems and Gear Design

Design of clutch systems - Single plate, multiplate, and cone clutch, Torque capacity and thermal analysis. Gear train layout and simulation. Bearing load calculations and selection. Design of 3-speed and 4-speed gearboxes.

Chassis, Frame, and Suspension Design

Load and stress analysis of vehicle frames. Design of Passenger and commercial vehicle frames, Leaf, coil, and torsion bar springs, Steering linkages and gearboxes.

Axle Systems and Drivetrain Design

Design and analysis of Propeller shaft and final drive gearing, Rear axle types: full-floating, semi-floating, three-quarter floating, Front axle stress and load distribution.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments / Case Study (10%), Quiz / Problem (10%),Virtual demonstration / Software Analysis (10%), Flipped Classroom (10%), Review of GATE & IES questions(10%)

References:

1. Dean Averns, "Automobile Chassis Design", Illife Book Co., 2001
2. Fenton, J. (1998). Handbook of automotive body and systems design. Professional Engineering Publishing.
3. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.

4. Crouse, W., & Anglin, D. (2010). Automotive mechanics (10th ed.). McGraw-Hill Education.
5. Milliken, W. F., & Milliken, D. L. (1995). Race car vehicle dynamics. SAE International.
6. Genta,LorenzoMorello,“TheAutomotiveChassisVolume1,Components Design”, Springer International Edition.2014
7. Stokes, “Manual gearbox design”, Butterworth-Heinemann 1992
8. “Design Data Hand Book”, PSG College of Technology, 2013- Coimbatore.
9. Robert C.Juvinall and Kurt M.Marshek, “Fundamentals of Machine component Design”,6th Edition, Wiley, 2017

E-Resources:

https://www.performancetrends.com/SuspAnzr.htm
https://www.performancetrends.com/ca20.htm
https://www.emachineshop.com/gear-design-software/
https://evolventdesign.com/pages/spur-gear-generator
https://www.studysmarter.co.uk/explanations/engineering/automotive-engineering/drivetrain-dynamics/

CO	Description of CO	PO	PSO1	PSO2
CO1	Understand automotive component design principles and material selection using CAD/CAE tools	PO1 (3), PO3 (2)	3	2
CO2	Apply simulation techniques to analyze engine components, powertrain, and transmission systems	PO1 (3), PO2 (2)	3	3
CO3	Analyze stresses, fatigue, vibration, and dynamic behavior of automotive systems	PO1 (3), PO3 (3)	2	3
CO4	Design and evaluate chassis, suspension, axle, and drivetrain systems for performance, durability, and safety	PO2 (2), PO3 (3)	3	3

AM25202	Vehicle Dynamics and Control	L	T	P	C
		3	0	2	4

Course Objectives:

This course is to provide students with a comprehensive understanding of the principles and applications of vehicle dynamics, including longitudinal, lateral, and vertical dynamics. Through theoretical knowledge and practical MATLAB simulations, students will learn to analyze and optimize vehicle performance and control systems. Additionally, the course aims to enhance students' skills through hands-on activities such as industrial visits, seminars, and project-based learning.

Introduction to Vehicle Dynamics

Basics of Vehicle Dynamics, Coordinate Systems and Notation, Forces and Moments Acting on a Vehicle, Tire Models and Characteristics

Practical: Implement various tire models in MATLAB and analyze their impact on vehicle handling and stability.

Longitudinal Dynamics

Acceleration, deceleration and Braking Dynamics, Detailed modeling of engine, transmission, and drivetrain components. Traction Control Systems

Practical: Implement traction control algorithms in MATLAB and evaluate their effectiveness in different driving conditions.

Lateral Dynamics

Steering Dynamics and their influence on vehicle direction and stability. Analysis of vehicle stability including understeer, neutralsteer and oversteer characteristics. Vehicle behavior during cornering, including the effects of speed and road conditions.

Practical: Use MATLAB to model and simulate vehicle response to various steering inputs and analyze stability.

Vertical Dynamics

Study of different types of suspension systems and their impact on ride quality. Analysis of factors affecting ride comfort and vehicle road holding capabilities. Examination of vehicle vibrations and methods to mitigate them.

Practical: Implement various suspension models in MATLAB and evaluate their impact on ride comfort and handling.

Control Systems for Vehicle Dynamics

Introduction to control theory principles and their application in vehicle dynamics. Study of various vehicle control systems(ABS, ESC, TCS) and their impact on safety and performance. Examination of ADAS technologies and their role in modern vehicles.

Practical: Implement ABS algorithms in MATLAB and analyze their effectiveness in different braking scenarios.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%
Assessment Methodology and weightage: Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)
References: 1. J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Interscience, 2008 2. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010 3. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014 4. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, SAE International, 2005 5. R. NakhaieJazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer, 2013
E-Resources: https://www.mathworks.com/solutions/automotive/vehicle-dynamics.html https://nptel.ac.in/courses/112/106/112106221/ https://github.com/RobertLaganiere/Pacejka-Tyre-Model https://www.sae.org/publications/technical-papers/ https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/mechanical-vibrations/

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain vehicle dynamic behavior, force systems, and tire characteristics	PO1 (3), PO2 (2)	3	2
CO2	Model and simulate longitudinal, lateral, and vertical dynamics using MATLAB	PO1 (3), PO3 (2)	3	3
CO3	Evaluate vehicle stability, ride comfort, and handling under varying operating conditions	PO2 (2), PO3 (3)	2	3
CO4	Analyze and optimize vehicle control systems such as ABS, ESC, TCS, and ADAS	PO3 (3)	3	3

AM25203	Engine and Vehicle Testing Laboratory	L	T	P	C
		0	0	4	2

Course Objectives:

The lab course aims to develop hands-on skills in performance testing, emission analysis, and diagnostic evaluation of internal combustion engines. It provides practical knowledge of standard servicing, adjustment, and alignment procedures for various vehicle systems. Additionally, the course focuses on critical analysis and interpretation of test data to assess vehicle efficiency, mechanical condition, and compliance with regulatory standards.

List of Experiments:

Engine Testing

1. Conduct performance and emission tests on an internal combustion (IC) engine.
2. Determine the frictional power of a petrol engine.
3. Perform a heat balance test on a diesel engine.
4. Evaluate the volumetric efficiency of a diesel engine.
5. Conduct a retardation test on a 4-stroke diesel engine.
6. Perform a Morse test to determine the indicated power of a multi-cylinder engine.
7. Analyze the effect of injection timing and injection pressure on emissionformation.

Vehicle Testing

8. Tinkering and painting of auto body parts.
9. Perform tightening and adjustment of wheel bearings.
10. Adjust pedal play in the clutch, brake, and handbrake lever.
11. Conduct a four-wheel alignment on a passenger vehicle.
12. Perform basic servicing of the transmission, braking, and suspension systems.
13. Fault Diagnosis Using OBD Kit.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

CO	Description of CO	PO	PSO1	PSO2
CO1	Perform engine performance, emission, and heat balance tests and interpret results	PO1 (3), PO4 (3)	3	3
CO2	Conduct vehicle servicing, alignment, adjustment, and maintenance procedures	PO2 (2), PO3 (2)	3	3
CO3	Diagnose engine and vehicle faults using testing equipment and OBD tools	PO2 (3), PO3 (2)	3	3

AM25204	Industrial Training	L	T	P	C
		0	0	0	2

Course Objectives:

To understand, learn and apply the principles and practices of Energy Conservation in Industrial Utilities through hands on training.

Guidelines:

- Each student has to undergo Industrial training for a minimum period of four weeks during the upcoming summer vacation (i.e., between II and III Semester).
- The Internship has to be undergone continuously for the entire period.
- The Internship must be carried out in an energy intensive industry (HT Consumer)
- The End Semester Examination must be conducted at the start of III Semester.
- The mark will be based on the project report (Introduction; Project or Training details;Techno Economics; Discussion; and Conclusion) and their presentation followed by oral examination on the same by internal examiner.

Weightage:
Assessment: 100%

	Description of CO	PO	PSO1	PSO2
CO1	Suggest measures for energy conservation in industrial utilities.	PO3 (3)	3	2
CO2	Prepare and present a detailed project report professionally	PO10 (3), PO11 (2)	2	3

Semester III

AM25301	Project Work I	L	T	P	C
		0	0	12	6

Course Objectives:

The main learning objective of this course is to prepare the students for identifying a specific problem for the current need of the society and or industry, through detailed review of relevant literature, developing an efficient methodology to solve the identified specific problem

Guidelines:

- Each PG student shall work individually on a selected specific topic.
- Which shall be approved by the Head of the Division under the supervision of a Faculty Member (Guide / Supervisor) who is familiar in the selected specific topic. The selected specific topic maybe theoretical and or experimental and or simulation and or case study. The students' Project Work – Phase I shall be evaluated through Internal Examination and End Semester Examination.
- The Internal Examination must be conducted periodically (Zeroth, First, Second and Third) through Project Work Review Presentation Meetings followed by questions from the panel of Review Committee Members comprising of two expert faculty members and a project coordinator.
- At the end of the semester, a detailed report on the work done by the PG student must be submitted with the approval from the Guide/Supervisor and the Review Committee Members. The Project Work – Phase I Report must contain the Introduction with clear definition along with detailed review of relevant literature on the selected specific problem; an efficient methodology to solve the selected specific problem along with necessary hypothesis and or experimental setup and or simulation and or case study for carrying out the research project work along with preliminary results; discussions, relevant conclusions and future direction along with specified references.
- The End Semester Examination must be conducted through Project Work Presentation followed by questions from the panel of Examiners comprising an External Examiner and Project Coordinator as Internal Examiner.

Semester IV

AM25401	Project Work II	L	T	P	C
		0	0	24	12

Course Objectives:

The main learning objective of this course is to prepare the students for solving the specific problem for the current need of the society and or industry, through the formulated efficient methodology, and to develop necessary skills to critically analyse and discuss in detail regarding the project results and making relevant conclusions.

Guidelines:

- The student may continue to work on the Project Work – I's selected topic as per the formulated efficient methodology under the same Faculty Member (Guide/Supervisor).
- The students' Project Work – II shall be evaluated through Internal Examination and End Semester Examination.
- The Internal Examination must be conducted periodically (First, Second and Third) through Project Work Review Presentation Meetings followed by questions from the panel of Review Committee Members comprising of two expert faculty members and a project coordinator.
- At the end of the semester, a detailed report on the work done by the PG student must be submitted with the approval from the Guide/Supervisor and the Review Committee Members. The Thesis (Project Work – II Report) must contain the Introduction with clear definition along with detailed review of relevant literature on the selected specific problem; an efficient methodology to solve the selected specific problem along with necessary theoretical hypothesis and or experimentation and or simulation and or case study for carrying out the research project work along with complete results with critical analysis and detail discussions, followed by relevant conclusions, along with specified references.
- The End Semester Examination must be conducted through Project Work Presentation followed by questions from the panel of Examiners comprising an External Examiner and Project Coordinator as Internal Examiner

PROGRAMME ELECTIVE COURSES

AM25001	Alternative Fuels and Propulsion Systems	L	T	P	C
		3	0	0	3

Course Objectives:

This course aims to provide comprehensive knowledge on the need, types, and applications of alternative fuels in internal combustion engines. It equips students with an understanding of the production technologies and properties of alcohols, vegetable oils, hydrogen, biogas, LPG, and natural gas. The course also emphasizes the methods of fuel utilization in SI and CI engines, performance and emission characteristics, and recent advancements in alternative fuel research and sustainability.

Alternative Fuels, Properties and Production Methods of Fuels

Need for alternative fuels. World and Indian energy scenario on alternative fuels. Production technologies for biofuels for internal combustion engines- Pyrolysis, gasification, digestion.

Alcohols

Alcohols as fuels. Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Blending, dual fuel operation, surface ignition and oxygenated additives. Performance, emission and combustion characteristics in CI and SI engines. Calculation of Performance parameters. Recent Trends.

Vegetable Oils

Various vegetable oils and their important properties. Different methods of using vegetable oils engines – Blending, preheating Transesterification and emulsification of Vegetable oils - Performance in engines – Performance, Emission and Combustion Characteristics in diesel engines. Role of Nano fluids, additives and cetane improvers for performance improvement of vegetable oils as fuel. Calculation of Performance parameters. Recent Trends.

Hydrogen

Production methods of hydrogen. Combustive properties of hydrogen. Problems associated with hydrogen as fuel and solutions. Different methods of using hydrogen in SI and CI engines. Performance, emission and combustion analysis in engines. Hydrogen storage - safety aspects of hydrogen. Recent Trends in Hydrogen research

Biogas, LPG and Natural Gas

Production methods of Biogas, Natural gas and LPG. Properties studies. CO2 and H2S scrubbing in Biogas., Modification required to use in SI and CI Engines- Performance and emission characteristics of Biogas, NG and LPG in SI and CI engines. Recent Trends in engine research.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:
Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.
2. Donald Klass, Biomass for Renewable Energy, Fuels, and Chemicals, 1998, Academic Press, ISBN: 978-0-12-410950-6.
3. Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer Verlag London Limited 2008, ISBN-13: 9781846289941
4. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
5. Technical papers of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
6. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_bt16
2. https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/
3. https://ocw.mit.edu/courses/2-60j-fundamentals-of-advanced-energy-conversion-spring-2020/
4. https://www.researchgate.net/publication/382547111_Alternative_Fuels_for_Sustainable_Combustion
5. https://www.nrel.gov/docs/fy01osti/27957.pdf

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain the need, production methods, properties, and engine utilization of alternative fuels including alcohols, vegetable oils, hydrogen, biogas, LPG, and natural gas	PO1 (3)	3	2
CO2	Apply alternative fuels in SI and CI engines by implementing blending, dual-fuel operation, and engine modification techniques	PO1 (3), PO2 (2)	3	3
CO3	Estimate engine performance parameters, emission characteristics, and efficiency for various alternative fuels	PO1 (3), PO2 (2)	3	3
CO4	Analyze combustion behavior, sustainability, safety aspects, and recent advancements in alternative fuel propulsion systems	PO2 (2), PO3 (3)	3	3

AM25002	Autonomous and Connected Vehicles	L	T	P	C
		3	0	0	3

Course Objectives:

This course introduces the fundamentals of autonomous vehicle technology, including SAE automation levels, path planning, and decision-making strategies. It covers sensors, perception systems, and AI-based visualization. Students will learn about vehicle communication networks, connected protocols, and explore human factors, ethics, and regulations for safe deployment.

Introduction to Autonomous Vehicle Technology

Introduction - SAE autonomous Level Classification-Examples-Application of Autonomous Vehicle-Advantages and Disadvantages of Autonomous Vehicles

Path Planning and Decision Making

Principles of decision making and path planning for autonomous vehicles-Decision making approaches-Approximation-Heuristic-Graph Based-Point guidance. Verification and validation of decision making and path planning- Application examples of task allocation and path planning algorithms.

Sensors, Perception and Visualisation

Introduction to sensors, perception and visualization for autonomous vehicles-Sensor integration architectures and multiple sensor fusion-AI algorithms for sensing and imaging-neural networks.

Networking and Connected Vehicles

Current and future vehicle networking technologies- CAN, LIN, MOST and Flex-ray. The use of modern validation and verification methods- software-in-the-loop, and hardware-in-the-loop techniques. The role of Functional Safety and ISO26262 within the overall control system. Inter-dependency between software engineering and control system-advanced test methods for the validation of safety-critical systems. connected vehicle control (CACC).Vehicle-to-everything (V2X), Applications such as intelligent traffic signals, collaborative adaptive cruise and vehicle platooning.

Human Factors and Ethical Decision Making

Introduction to Human Factors-Human Performance: Perception and Attention-Situation Awareness and Error-Human Reliability: Driver Workload and Fatigue-Emotion and Motivation in Design-Trust in Autonomous Vehicles and Assistive Technology-Designing ADAS Systems-Driverless Vehicles and Ethical Dilemmas: Human Factors and Decision-Making Software-Application of Human Factors in Autonomous Vehicles. International and national regulatory frameworks for CAV and their safe operation

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Nicu Bizon, Lucian Dascalescu, Naser Mahdavi Tabatabaei, "Autonomous Vehicles: Intelligent Transport Systems and Smart Technologies,". Nova Science Publishers, 2014.
2. Andreas Herrmann, Walter Brenner, Rupert Stadler, “Autonomous Driving: How the Driverless Revolution will Change the World”, Emerald Publishing Limited ,2018.
3. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems” Springer, 2019.
4. Woodrow Barfield, Thomas A. Dingus,"Human Factors of Intelligent Transportation Systems”, Psychology Press,1997.
5. Nikolaus Correll, Bradley Hayes, et al., "Introduction to Autonomous Robots: From Kinematics to Path Planning,”, The MIT Press, 2022.
6. George Dimitrakopoulos, Aggelos Tsakanikas and Elias Panagiotopoulos,” Autonomous Vehicles: Technologies, Regulations, and Societal Impacts”, Elsevier, 2021.
7. Hod Lipson, Melba Kurman,” Driverless: Intelligent Cars and the Road Ahead”, MIT Press, 2016.

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain autonomous vehicle concepts, SAE automation levels, sensors, perception systems, and connected vehicle fundamentals	PO1 (3)	3	2
CO2	Apply path planning, decision-making algorithms, sensor fusion, and communication protocols to vehicle systems	PO1 (3), PO2 (2)	3	3
CO3	Estimate system performance, safety margins, and communication effectiveness for autonomous and connected vehicles	PO2 (3), PO3 (2)	3	3
CO4	Analyze human factors, ethical issues, and regulatory compliance in designing and deploying autonomous and connected vehicles	PO3 (3)	3	3

AM25003	Automotive Regulations	L	T	P	C
		3	0	0	3

Course Objectives:

This course provides a comprehensive understanding of global automotive regulatory frameworks, focusing on safety, emissions, noise, and emerging technologies. It equips students with the knowledge to interpret, apply, and critically evaluate international standards and compliance mechanisms, preparing them for roles in regulatory affairs, vehicle certification, and sustainable mobility innovation.

Foundations of Automotive Regulations

Historical evolution and global regulatory ecosystems Comparative analysis: USA (FMVSS), EU (UNECE), India (CMVR), Japan, China Harmonization efforts: UNECE WP.29, WTO TBT, ISO, SAE Institutional roles: NHTSA, ARAI, MoRTH, VCA, TÜV, JASIC Key compliance concepts: Type Approval, CoP, Mutual Recognition Agreements

Vehicle Safety Standards and Assessment

Active & passive safety systems: ADAS, airbags, ESC, ABS Global NCAP programs: Euro NCAP, Bharat NCAP, JNCAP, IIHS Crashworthiness, pedestrian protection, side-impact standards Safety testing protocols: frontal, side, rollover, whiplash Integration of digital safety tools: simulations, digital twins

Environmental and Emissions Compliance

Emission sources and control technologies Global emission norms: Euro 6d, BS VI, EPA Tier 3, China 6 OBD, RDE, and In-Service Conformity EV and hybrid vehicle regulations: battery safety, recycling Fuel economy & CO_2 targets: WLTP, FTP-75, MIDC

Noise and Vehicle Dynamics Regulations

Noise sources: powertrain, tire, aerodynamic. Global noise standards: UNECE R51, ISO 5130, pass-by noise. Vehicle dynamics: braking, acceleration, handling tests. Homologation procedures and test track protocols Certification, audits, and enforcement mechanisms

Future Mobility and Regulatory Challenges

Autonomous and connected vehicle regulations Cybersecurity, OTA updates, and data privacy Legal and ethical issues in AI-driven mobility Shared mobility, micromobility, and drone regulations Digital compliance tools: virtual testing, AI in homologation.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Brown, J. C. (2010). Motor vehicle structures: Concepts and fundamentals. SAE International.
2. Jurgen, R. K. (Ed.). (2006). Automotive regulatory engineering. SAE International.
3. Stedman, D. H. (2000). Vehicle emission inspection and maintenance. Springer.
4. Seiffert, U., & Wech, L. (2007). Automotive safety handbook. SAE International.
5. European Commission. (n.d.). Handbook of vehicle safety regulation. Publications Office of the European Union.

E-resources:

1. United Nations Economic Commission for Europe (UNECE). (n.d.). Vehicle regulations under WP.29. Retrieved from https://unece.org/transport/vehicle-regulations
2. SAE International. (n.d.). SAE MOBILUS digital library. Retrieved from https://www.sae.org/publications
3. Euro NCAP Technical Reports
4. EPA Emissions Standards
5. VCA UK Homologation

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain global automotive regulatory frameworks, safety, emissions, noise, and homologation procedures	PO1 (3)	3	2
CO2	Apply compliance methods, testing protocols, and certification processes to vehicles and mobility systems	PO1 (3), PO2 (2)	3	3
CO3	Estimate vehicle performance against regulatory standards, including emissions, noise, safety, and fuel economy targets	PO2 (3), PO3 (2)	3	3
CO4	Analyze emerging regulatory challenges for autonomous, connected, and shared mobility, including cybersecurity, AI ethics, and digital compliance	PO3 (3)	3	3

AM25004	Engine Combustion Thermodynamics and Engine Heat Transfer	L	T	P	C
		3	0	0	3

Course Objectives:

This course aims to impart in-depth knowledge of combustion processes and thermodynamic principles in internal combustion engines. It focuses on fuel–oxidizer reactions, flame dynamics, and combustion characteristics in SI and CI engines. The course also covers heat transfer mechanisms and thermal analysis of engine components. Experimental techniques for analyzing combustion and heat transfer are also introduced.

Introduction to Combustion Processes

Definition for Fuel and Oxidizer – types – Various combustion modes- Combustion in premixed laminar and premixed turbulent combustion - Flame Speed – Burning Velocity - diffusion flames – Combustion process in IC engines.

Thermodynamics of Combustion

Thermodynamics of combustion – Thermodynamic Properties – Ideal gas law – Gas mixture combustion – Stoichiometric combustion – Thermochemistry – Hess's law- Adiabatic flame temperature – Physics of combustion – Fick's law of species diffusion – Conservation equations – Boundary layer concept

Normal, Abnormal Combustion in SI Engines

Stages of combustion – Flame propagation –– Flame Limits – Flame Extinction - Rate of pressure rise – Cycle to cycle variation – Abnormal combustion – Theories of detonation – Effect of engine operating variables on combustion –Example problems.

Combustion And Heat Transfer in IC Engines

Droplet and spray combustion theory – delay period – Peak pressure – Calculation of Heat release Rate – Gas temperature calculations – Diesel knock. Basic definitions – Convective heat transfer – Radiative heat transfer – Heat transfer, temperature distribution and thermal stresses in piston – Cylinder liner – Cylinder head – fins and valves.

Experimental Investigation of Combustion and Heat Transfer in IC Engines

Photographic studies of combustion processes – Endoscopy Technique. P-θ diagrams in SI and CI engines, Post Processing for combustion parameters. Assembly – Temperature measurement in piston – cylinder liner – Cylinder head and engine valves.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. John. B. Heywood,' Internal Combustion Engines'", McGraw Hill Co., Newyork, 2017.
2. Spalding.D.B., "Some fundamental of Combustion", Butterworth Science Publications, London, 1985.
3. Taylor.E.F."TheInternal Combustion Engines ", International TextBook Co., Pennsylvania, 1982.
4. V.Ganesan, 'Internal combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2012.
5. Ashley Campbel, "Thermodynamic analysis of combustion engine", John book company, New york, 1979.

E-Resources:

1. https://ocw.mit.edu/courses/2-51-intermediate-heat-and-mass-transfer-fall-2008/
2. https://ocw.mit.edu/courses/2-051-introduction-to-heat-transfer-fall-2015/
3. https://archive.org/details/john-heywood-internal-combustion-engine-fundamentals-mc-graw-hill-science-engineering-math-1988
4. https://archive.org/details/internalcombusti0000ferg/page/n5/mode/2up

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain combustion processes, thermodynamic principles, and heat transfer mechanisms in SI and CI engines	PO1 (3)	3	2
CO2	Apply thermodynamic equations, combustion theory, and heat transfer correlations to analyze engine performance	PO1 (3), PO2 (2)	3	3
CO3	Estimate combustion parameters, flame characteristics, heat release rates, and thermal stresses in engine components	PO1 (3), PO3 (2)	3	3
CO4	Analyze abnormal combustion, engine knock, and heat transfer phenomena to optimize engine design and operation	PO3 (3)	3	3

AM25005	Green Vehicle Technology	L	T	P	C
		3	0	0	3

Course Objectives:

This course aims to impart knowledge on environmentally sustainable vehicle technologies, focusing on the development and application of cleaner mobility solutions. It explores various propulsion systems including electric, hybrid, fuel cell, and alternative fuel-based technologies. Additionally, the course covers emission control methods and examines future trends in green mobility to support a sustainable transportation ecosystem.

Introduction to Green Mobility

Need for sustainable transportation, Environmental impact of conventional vehicles, Definition and classification of green vehicles, Overview of global and Indian policies on green mobility, Introduction to Life Cycle Analysis (LCA) for vehicles.

Electric Vehicles (EVs)

EV architecture and components, Types of electric vehicles: BEV, HEV, PHEV, FCEV, Electric motors for EVs: BLDC, PMSM, and Induction motors, Battery technology: Li-ion, NiMH, BMS, Charging infrastructure and types (AC/DC, slow/fast charging), Regenerative braking.Green storage – Redox technology

Hybrid and Fuel Cell Vehicles

Hybrid vehicle configurations: Series, Parallel, Series-Parallel, Power split devices and control strategies, Energy management strategies in HEVs, Fuel cell principles and types (PEMFC, SOFC), Fuel cell vehicle architecture and hydrogen storage, Comparison of hybrid vs fuel cell systems.

Alternative Fuels and Emission Control

Biofuels: Ethanol, Methanol, Biodiesel – production and properties, Hydrogen and CNG/LPG – combustion characteristics and applications, Dual fuel and flex-fuel engines, Advanced emission control systems: SCR, DPF, EGR, TWC, Emission standards: Bharat Stage, Euro norms, and CAFÉ norms.

Trends, Challenges and Case Studies

Energy and environmental impact analysis of green vehicles, Vehicle-to-grid (V2G) and smart grid integration, Autonomous and connected electric vehicles, Barriers to adoption: Technical, economic, infrastructure, Government policies and incentives (FAME India, PLI schemes), Case studies of Tesla, Toyota Prius, Hyundai NEXO, and Tata Nexon EV.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.
3. Mehrdad Ehsani et al., Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press.
4. SAE Papers and Journals on Green Vehicle Technologies
5. ISRO/ARAI/NITI Aayog reports on EV and hydrogen roadmap
6. Government portals (MNRE, MoRTH, FAME India)

E-Resources:

1. NPTEL Lecture:
   - Sustainable Transportation Systems – IIT Madras (Prof. Ligy Philip), https://nptel.ac.in/courses/105106219
   - Electric Vehicles – Introduction and Basics by Prof. L.Umanand, IISc Bangalore https://nptel.ac.in/courses/108108179
   - Fuel Cells – Prof. S. Ghosh, IIT Kharagpur https://nptel.ac.in/courses/103105150
2. Paper: Environmental impact of vehicles: A review – ScienceDirect https://doi.org/10.1016/j.rser.2018.05.002
3. Government Policies (India): https://www.niti.gov.in/green-mobility https://fame2.heavyindustry.gov.in/
4. ARAI Technical Reports: Alternative Fuel Guidelines and Emission Norms https://www.araiindia.com
5. Bharat Stage Norms Overview: https://www.cpcb.nic.in
6. Government Portals:FAME India Scheme – MoHI,MNRE Hydrogen Roadmap

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain concepts of green mobility, EVs, hybrid/fuel cell vehicles, alternative fuels, and emission control methods	PO1 (3), PO3 (2)	3	2
CO2	Apply principles of electric, hybrid, fuel cell, and alternative fuel vehicle design and control strategies	PO1 (3), PO2 (2)	3	3
CO3	Estimate energy efficiency, emission levels, and environmental impact for different green vehicle technologies	PO1 (3), PO3 (2)	3	3
CO4	Analyze trends, challenges, and case studies to optimize green vehicle performance and sustainability	PO3 (3)	3	3

AM25006	IC Engine Process Modelling	L	T	P	C
		3	0	0	3

Course Objectives:

This course aims to provide students with a strong foundation in modelling and simulation techniques for internal combustion engine processes. It emphasizes the development of thermodynamic, fluid dynamic, and combustion models for SI, CI, and advanced engines. The course includes simulation of gas exchange, heat transfer, and frictional effects, along with hands-on experience in engine simulation software and validation techniques.

Introduction to Simulation

Introduction to Simulation, Advantages of computer simulation, Classification of engine models. Intake and exhaust flow models – Quasi steady flow -Filling and emptying -Gas dynamic Models. Thermodynamic based in cylinder models. Step by step approach in SI engine simulation. Overview of modelling softwares.

Stoichiometry and Adiabatic Flame Temperature

Reactive processes, Heat of reaction, measurement of URP, measurement of HRP. Introduction - combustion equation for hydrocarbon fuels. Calculation of minimum air, excess air and stoichiometric air required for combustion. Introduction, complete combustion in C-H- N-O systems, constant volume adiabatic combustion, constant pressure adiabatic combustion, calculation of adiabatic flame temperature, isentropic changes of state.

SI Engine Simulation

SI Engine simulation with air as working medium, deviation between actual and ideal cycle. Fuel air cycle analysis - Temperature drop due to fuel vaporization, full throttle operation, work output and efficiency calculation, part-throttle operation, engine performance at part throttle, super charged operation. SI Engines simulation with progressive combustion. Models for mass burnt fraction.

SI Engine Simulation with Gas Exchange Process

Introduction, gas exchange process, Heat transfer process, friction calculations, comparison of simulated values, validation of the computer code, engine performance simulation, pressure crank angle diagram, brake power, brake thermal efficiency, effect of speed on performance and analysis of the data. Case study using engine simulation Software. Overview of CFD modelling.

Engine Simulation for CI and Advanced Engines

Zero, one and multizone models for diesel engine combustion. Wiebe’s Model, Whitehouse model and Watson model for diesel combustion. Heat release rate and heat transfer models. Equilibrium calculations. Engine modeling for dual fuel engine- Multifuel engines. Programming of the modeling process and validation of the models. Parametric studies on simulated engine performance

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage: Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)
References: 1. Heywood, J. B. (2018). *Internal combustion engine fundamentals* (2nd ed.). McGraw-Hill Education. 2. Guzzella, L., & Onder, C. H. (2010). *Introduction to modeling and control of internal combustion engine systems* (2nd ed.). Springer. 3. Ferguson, C. R., & Kirkpatrick, A. T. (2015). *Internal combustion engines: Applied thermosciences* (3rd ed.). Wiley. 4. Stone, R. (2012). *Introduction to internal combustion engines* (4th ed.). Palgrave Macmillan. 5. Pulkrabek, W. W. (2003). *Engineering fundamentals of the internal combustion engine* (2nd ed.). Pearson Education.
E-resources: 1. https://ocw.mit.edu 2. https://www.engineeringtoolbox.com 3. https://dokumen.pub/internal-combustion-engine-fundamentals-2nbsped-9781260116106.html 4. https://dokumen.pub/internal-combustion-engine-fundamentals-2nbsped-9781260116106.html

CO	Description of CO	PO	PSO1	PSO2
CO1	Explain fundamentals of IC engine modelling, simulation techniques, and thermodynamic/combustion principles	PO1 (3), PO3 (2)	3	2
CO2	Apply simulation techniques for SI, CI, and advanced engine processes including gas exchange, heat transfer, and friction analysis	PO1 (3), PO2 (2)	3	3
CO3	Estimate engine performance parameters such as work output, efficiency, heat release rate, and pressure-crank angle variations from simulations	PO1 (3), PO3 (2)	3	3
CO4	Analyze simulation results to optimize engine design, validate models, and study parametric effects on performance	PO3 (3)	3	3

AM25007	Advanced Automotive Electronics	L	T	P	C
		3	0	0	3

Course Objectives:

To equip students with in-depth knowledge of modern automotive electronic systems and their integration in intelligent vehicles. The course aims to cover advanced concepts in embedded control, communication protocols, driver assistance systems, and vehicle networking. It prepares students to design and analyze complex automotive electronic architectures for safety, performance, and automation.

Introduction to Advanced Automotive Electronics

Role of electronics in modern and intelligent vehicles - Evolution from conventional to electronic-based control systems = Overview of automotive microcontrollers and ECUs

Communication Protocols and In-Vehicle Networking

CAN, LIN, FlexRay, MOST, and Ethernet communication protocols - Gateway modules and signal processing - Diagnostics protocols (UDS, OBD-II)

Powertrain and Body Control Systems

Electronic fuel injection, ignition systems, and transmission control - Body electronics: power windows, HVAC, lighting control - Role of sensors and actuators

Driver Assistance and Safety Systems

Advanced Driver Assistance Systems (ADAS): LKA, ACC, AEB, etc. - Safety electronics: ABS, ESC, TPMS, airbag systems - Sensor fusion and control strategies

Intelligent and Autonomous Vehicle Technologies

AI integration in automotive electronics - V2X communication, telematics, and cybersecurity in ECUs - Software Over-the-Air (OTA) updates and real-time OS in ECUs

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Robert Bosch GmbH, "Automotive Handbook", 10th Edition, Wiley, 2021.
2. Ronald K. Jurgen, "Automotive Electronics Handbook", McGraw-Hill, 2nd Edition, 2015.
3. William Ribbens, "Understanding Automotive Electronics", 8th Edition, Butterworth-Heinemann, 2017.
4. Tom Denton, "Advanced Automotive Fault Diagnosis", Routledge, 4th Edition, 2017.

5. NajamuzZaman, "Automotive Control Systems", Springer, 2019.

E-Resources:

NPTEL Course: "Automotive Control Systems" – https://nptel.ac.in/courses/108103009
Vector Learn Platform – https://vector.com/vi-education
Bosch Mobility Solutions – https://www.bosch-mobility.com
IEEE Xplore: Automotive Electronics Section – https://ieeexplore.ieee.org
MOOC: Udacity's Self-Driving Car Engineer Nanodegree – https://www.udacity.com

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the structure and role of automotive electronic systems	PO1 (3), PO3 (2)	3	2
CO2	Apply knowledge to analyze in-vehicle networking and communication protocols	PO2 (3), PO3 (2)	3	2
CO3	Estimate performance and behavior of in-vehicle networking and communication protocols	PO2 (3), PO3 (2)	3	2
CO4	Analyze and evaluate the functionality and design of ADAS and safety systems	PO3 (3), PO5 (2)	3	3
CO5	Integrate and simulate intelligent and autonomous vehicle technologies	PO1 (3), PO2 (3), PO3 (2)	3	3

AM25008	Automotive Embedded Systems	L	T	P	C
		3	0	0	3

Course Objectives:

To introduce students to the fundamentals of embedded systems used in modern automobiles, including microcontrollers, ECUs, sensors, and actuators. The course focuses on real-time software design, in-vehicle communication (CAN, LIN), diagnostics, and functional safety (ISO 26262). Students will gain practical insights into embedded applications in electric vehicles and the Indian automotive ecosystem.

Introduction to Automotive Embedded Systems

Overview of embedded systems in vehicles – functions, classifications, and role in modern automotive platforms. Introduction to Electronic Control Units (ECUs), microcontroller architectures, and powertrain/body electronics. Study of the automotive V-model for system development. Basics of real-time systems, constraints, and design lifecycle. Indian automotive embedded industry landscape and regulatory influences.

Microcontrollers and Real-Time Operating Systems (RTOS)

Structure and architecture of automotive-grade microcontrollers (ARM Cortex-M/R, Infineon AURIX, NXP). Programming in C/C++ for embedded automotive applications. Basics of RTOS: tasks, scheduling, multitasking, semaphores, and inter-task communication. Implementation of real-time scheduling policies and memory protection. Case studies of microcontrollers in Engine Management Systems (EMS) and Battery Management Systems (BMS).

Sensors, Actuators, and Signal Conditioning

Introduction to automotive sensors: position, temperature, pressure, speed, knock, oxygen, and LiDAR. Actuators: motors, solenoids, fuel injectors, and throttle bodies. Signal acquisition and conditioning, A/D and D/A conversion. Sensor fusion and diagnostics. Applications in Advanced Driver Assistance Systems (ADAS) and electric powertrains.

In-Vehicle Communication and Diagnostics

Communication protocols: CAN, LIN, FlexRay, and Ethernet. Message arbitration, error handling, and bus analysis using CANoe/CANalyzer. UDS and OBD-II diagnostic standards and protocols. Design of diagnostic stacks. Vehicle-to-ECU and ECU-to-ECU data flow. Cybersecurity considerations in automotive communication.

Functional Safety, Software Development and Future Trends

Introduction to ISO 26262 – safety lifecycle, ASIL levels, and hazard analysis. Model-Based Design using MATLAB/Simulink. Hardware-in-the-Loop (HIL) simulation. Introduction to AUTOSAR architecture and software stack. Future trends: Over-the-Air (OTA) updates, AI in embedded systems, and autonomous vehicle platforms. Government initiatives in India related to vehicle safety and embedded system integration.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Rajkamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill Education, 3rd Edition.
2. Jonathan W. Valvano, Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, CreateSpace, 2nd Edition.
3. William Ribbens, Understanding Automotive Electronics, Elsevier, 8th Edition.
4. Nicolas Navet & Francoise Simonot-Lion, Automotive Embedded Systems Handbook, CRC Press.
5. Robert Bosch GmbH, Automotive Handbook, 10th Edition, Wiley.
6. Qing X. Zhu, Vehicle Functional Safety: ISO 26262 and Beyond, Springer, 2021.
7. James K. Peckol, Embedded Systems: A Contemporary Design Tool, Wiley, 2nd Edition.
8. Peter Marwedel, Embedded System Design, Springer, 3rd Edition.
9. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufmann, 3rd Edition.
10. P.A. Laplante, Real-Time Systems Design and Analysis, Wiley-IEEE Press, 4th Edition.

E-resources:

1. **ISO 26262** – Functional Safety for Road Vehicles
2. **SAE J1939 / J1979 –** Diagnostics over CAN
3. **SAE J3061** – Cybersecurity Guidebook for Cyber-Physical Vehicle Systems
4. **UDS (ISO 14229)** – Unified Diagnostic Services
5. **OBD-II Protocol Documentation**
6. **AUTOSAR Specifications –** Architecture, Software Component Templates, etc.
7. **CAN, LIN, and FlexRay Protocol Standards –** Bosch and ISO Documentation

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the architecture, development, and role of automotive embedded systems	PO1 (3), PO3 (2)	3	2
CO2	Apply programming, RTOS, and microcontroller-based concepts in automotive applications	PO2 (3), PO3 (2)	3	2
CO3	Estimate performance, behavior, and response of sensors, actuators, and in-vehicle communication	PO2 (3), PO3 (2)	3	2
CO4	Analyze in-vehicle communication protocols, diagnostic features, and ADAS/safety system design	PO3 (3), PO5 (2)	3	3

AM25009	Automotive Instrumentation and Testing	L	T	P	C
		3	0	0	3

Course Objectives:

This course aims to provide theoretical and applicative knowledge in automobile test instrumentation. The students would be well aware of the experimental methods followed in industries. Additionally, the course aims to familiarize the students on standard test codes.

Mechanical Measurement

Introduction to measurements – Construction, principle, working of Instruments for measuring force, torque, pressure, temperature, fluid flow, velocity, rotational speed.

Vibration and Body Test

Vibration measurement instrument – accelerometer and signal conditioning. Dynamic simulation sled testing, methodology, vehicle acceleration measurement and documentation. Dolly roll over test, dolly role over fixture, photographic / video coverage. Vehicle roof strength test –. Door system crush test – wind tunnel tests.

Crash and Brake Test

Crash tests –standards – road hazard impact test for wheel and tyre assemblies, test procedures, failure and performance criteria. Bumpers - types of tests, pendulum test, fixed collision barrier test, procedure, performance criteria. Air and hydraulic brake test, air brake actuator, valves test, performance requirements.

Engine Experimental Techniques

I.S Code for Engine testing – Instruments for performance testing of engine, Instrumentation for measuring noise, vibration in cylinder, different types of engine tests are performed within the industry.

Vehicle Experimental Techniques

Laboratory tests- test tracks - Endurance Tests - Dynamic cornering fatigue, dynamic radial fatigue tests – procedure, bending moment and radial load calculations.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%), Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Crouse W H and Anglin D L., “Automotive Mechanics”’ Tata McGraw Hill Publishing Company, 2004.
2. J.G .Giles, Vehicle Operation & Testing. Volume 7 of Automotive technology series, Iliffe,1969
3. Richard D. Atkins, “An Introduction to Engine Testing and Development”,

SAE International 2009.
4. Beckwith TG and Buck N L, "Mechanical Measurements", Addition Wesley Publishing Company Limited, 1995.
5. Jain R K "Mechanical and Industrial Measurements", Khanna Publishers, Delhi, 1999.
6. Stockel M W, "Auto Mechanics Fundamentals", Good Heart-Wilcox Co., Inc., 2000.

E-resources:

1. https://law.resource.org/pub/in/bis/S08/is.14817.3.2004.pdf
2. https://morth.nic.in/sites/default/files/ASI/Draft%20AIS%20197%20.pdf
3. https://www.acma.in/uploads/otherdocmanager/Annexure_VIII_to_XIV.pdf
4. https://www.araiindia.com/services/department-and-laboratories/emission-testing
5. https://www.youtube.com/watch?v=GI-vG3QI8r8
6. https://www.natrax.in/test-track/

CO	CO Description	PO	PSO1	PSO2
CO1	Explain and demonstrate the understanding of engine testing procedures	PO1 (3), PO3 (2)	3	2
CO2	Apply measurement strategies for temperature, pressure, mass flow, and velocity	PO2 (3), PO3 (2)	3	2
CO3	Estimate engine performance using sensors and instrumentation, and interpret test data	PO2 (3), PO3 (2)	3	2
CO4	Analyze and develop systems to support sustainable environmental practices	PO3 (3), PO5 (2)	3	3

AM25010	Automotive Mechatronics	L	T	P	C
		3	0	0	3

Course Objectives:

To identify and understand the applications of automotive mechatronics across various sub-domains of automobiles, including engine management, transmission, braking, steering, suspension, and infotainment systems. The course also explores its role in enabling advanced technologies such as ADAS, electric powertrains, and autonomous driving for improved vehicle performance, safety, and efficiency.

Introduction

Fundamentals of Mechatronics, Electronics Components, Microprocessor, Ports, Memory, Buses, Microcontroller, Fetch-Execute sequence, Programming, Electronic Control Unit, Testing of Microcontroller Systems. Control System: Open and closed loop control strategies, PID control, Look up tables, Modern control strategies: Fuzzy logic and adaptive control

Automotive Sensors and Actuators

Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, detonation sensor, emission sensors, Actuators: solenoid actuator, stepper motors, relays, electrohydraulic actuators.

Automotive Engine Management System

Electronic control of carburation, Fuel injection, Electronic Fuel Injection, Types of Electronic fuel injection - Throttle Body Injection, Multi-Point Fuel Injection & Gasoline Direct Injection, Ignition System, Ignition System, Electronic Ignition System and its advantages, Fuel control maps, CI Engine Management. Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Exhaust emission control systems, 2and 3-way catalytic converter.

Vehicle Networking and Diagnosis

Basic principles of networking, Network topology, Network organization, OSI reference model, Control mechanisms, Communication protocols in embedded systems, Vehicle Communication Protocols, Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Examples of networked Vehicles, Bus system-CAN, LIN, Flex ray – MOST. Diagnosis: tools and equipment, Oscilloscope, onboard diagnosis system.

Applications

Cruise control, adaptive cruise control, central locking, Safety & security systems: Airbag, Keyless entry systems, Voice alert system, Collision Avoidance Radar warning system. Chassis Systems: Anti-lock Braking System, Traction Control system, Electronic Stability control system, Electronic power Steering system, Tire Pressure Monitoring System. Automatic Transmission, Use of Machine learning and data analytics for the automotive applications (ADAS, vehicle Autonomy, prognostics, health monitoring).

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%).

References:

1. Tom Denton, “Automotive Electrical and Electronics Systems,” Third Edition, SAE International, 2004.
2. Barry Hollembeak, “Automotive Electricity, Electronics & Computer Controls”, Delmar Publishers, 7 th edition, 2019.
3. Barry Holembeak, “Automotive Electrical and Electronics”, Delmar Publishers Clifton Park, USA, 2010.
4. William Ribbens, " Understanding Automotive Electronics - An Engineering Perspective”, 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.
5. Konrad Reif, Automotive Mechatronics: Automotive Networking, Driving Stability Systems, Electronics (Bosch Professional Automotive Information), Springer Fachmedien Wiesbaden, 2014.

E-Resources:

https://nptel.ac.in/courses/112107298
https://www.youtube.com/watch?v=sz8cqygvPC4&t=199s
https://youtu.be/TqQE0xkCJ8c?si=jARtor40esjE9g1n
https://www.youtube.com/watch?v=wAF8sYS_zpM&t=479s
https://www.youtube.com/watch?v=FqLDpHsxvf8&t=256s
https://www.youtube.com/watch?v=KfGZW9urj0U

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the fundamentals of automotive mechatronics, sensors, actuators, and engine control systems	PO1 (3), PO3 (2)	3	2
CO2	Apply programming, control strategies, and sensor-actuator interfacing in automotive systems	PO2 (3), PO3 (2)	3	2
CO3	Analyze vehicle networking, embedded communication protocols, and diagnostics for optimal operation	PO3 (3), PO5 (2)	3	3
CO4	Integrate mechatronic systems with ADAS, electric powertrains, and autonomous vehicle applications	PO1 (3), PO2 (3), PO3 (2)	3	3

AM25011	Automotive Safety Systems	L	T	P	C
		3	0	0	3

Course Objectives:

This course introduces the fundamental concepts and classifications of automotive safety systems, covering both passive safety equipment and modern convenience features. It familiarizes students with active safety technologies and Advanced Driver Assistance Systems (ADAS). The course also explores vehicle integration with navigation and vision-based sensor systems, and provides an overview of SAE automation levels in the context of autonomous vehicle safety.

Concepts of Automotive Safety

Automotive safety: Introduction and Types. Active safety: driving safety, conditional safety, Perceptibility safety, operating safety. Passive safety: Design of body for safety. Concept of crumble zone, Safety Cage. Optimum crash pulse, deceleration on impact with stationary and movable obstacles. Design for Crashworthiness. NCAP. ISO26262

Passive Safety Equipments and Convenience System

Seat belt, Seat belt tightener system and importance, collapsible steering column. Air bags and its activation. Designing aspects of automotive bumpers and materials for bumpers. Steering and mirror adjustment, central locking system, Tire pressure Monitoring system, rain sensor system, Automated wiper system.

Active Safety

Antilock braking system, Stability Control. Adaptive cruise control, Lane Keep Assist System, Collision warning, avoidance system, Blind Spot Detection system, Driver alertness detection System. ADAS.

Vehicle Integration and Connected Vehicle

Looking out sensors and Looking in sensors, Intelligent vision system, Vehicle Integration system. Global Positioning System. Vehicle Navigation System. Road Network, V2V.

Autonomous Vehicle

SAE Levels of Driving Automation, Level 0 – No Driving Automation, Level 1 – Driver Assistance, Level 2 – Partial Driving Automation, Level 3 – Conditional Driving Automation, Level 4 – High Driving Automation, Level 5 – Full Driving Automation.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Ljubo Vlacic, Michel Parent, Fumio Harashima – “Intelligent Vehicle Technologies Theory and Applications” -Butterworth-Heinemann, 2001

2. J. Marek, H.-P. Trah, Y. Suzuki, I. Yokomori - “Sensors for Automotive Applications“ - WILEY-VCH Verlag GmbH & Co. 2003
3. Robert Bosch GmbH - “Safety, Comfort and Convenience Systems”- Wiley; 3rd edition 2007 Bosch, “Automotive Handbook”, 6th edition, SAE, 2004.
4. J. Powloski - “Vehicle Body Engineering” - Business books limited, London - 1969.
5. Ronald.K. Jurgen - “Automotive Electronics Handbook” - Second edition- McGraw-Hill Inc., - 1999.
6. ARAI Safety standards

CO	CO Description	PO	PSO1	PSO2
CO1	Explain types of automotive safety and their relevance in vehicle design	PO1 (3), PO3 (2)	3	2
CO2	Describe passive safety features like airbags, seat belts, and bumpers with design considerations	PO2 (3), PO3 (2)	3	2
CO3	Analyze and apply active safety systems such as ABS, stability control, and ADAS technologies	PO3 (3), PO5 (2)	3	3
CO4	Integrate sensor systems, navigation tools, and automation levels for enhanced vehicle safety	PO1 (3), PO2 (3), PO3 (2)	3	3

AM25012	Vehicle Electrical and Electronics System	L	T	P	C
		3	0	0	3

Course Objectives:

This course introduces the fundamental concepts, need for different electrical circuits, starter batteries, starter motor and alternator in the vehicle. It familiarizes students with ignition, lighting and auxiliary system used in modern vehicles The course also explores different conventional and modern architecture networking in vehicles

Fundamentals of Electrical Circuits, Battery, Starting and Charging Systems

D.C fundamentals: ohm's law, KVL & KCL law, AC Fundamentals: Analysis of simple RC, RL and RLC series and parallel circuits and phasor diagrams. Lead acid battery: - Design, operating principle, characteristics, ratings and testing. Alternators: –Principle, Voltage regulation, Overvoltage regulation, characteristics curve- Alternator circuits and designs. Starter Motors: - Overview, Working - Types of starter motor- starter motor design -design variations – starter motor control and power circuits

Induction Motor & Drives

Construction and principle of operation - torque and torque-slip characteristics- Efficiency- Application starting methods – speed control drives of induction motor.

Power Electronics and Convertors

Power diodes and its characteristics - BJT, MOSFET, IGBT, SCR- Controlled Rectifiers and AC voltage Controllers, DC to DC Converters- Buck, Boost, Buck-Boost converters, Inverters- voltage, current, resonant

Transducers and Signal Conditioning

Transducer characteristics and classification, variable resistance-based transducers- strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, piezo-resistive sensor, variable inductance-based transducers-LVDT, Induction potentiometer, Capacitive transducers- Capacitive pressure sensor, Proximity sensor- Piezoelectric transducer – Hall Effect transducer-automotive application of sensors, DAC and ADC principle, ADC IC's

Embedded System and Vehicle Networking

Introduction to Embedded Systems –built in features for embedded Target Architecture (ARM processor) – selection of Embedded processor – DMA- memory devices – Memory management methods-memory mapping, cache replacement policies- Timer and Counting devices, Data transfer - automotive electronics systems, -networking fundamentals - network topology, organization -OSI reference model-control mechanisms, -communication protocols in embedded systems, vehicle communication protocols, cross-system functions, - requirements for bus systems- Classify bus systems - network coupling - CAN, LIN, FlexRay,

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology and weightage: Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5
2. Ned Mohan, T.M.Undeland, W.P.Robbins, ”Power Electronics: Converters, applications and design”, John Wiley and Sons, 3rd Edition (reprint), 2009
3. Rashid, M.H., “Power Electronics – Circuits, Devices and Applications”, PHI, Fourth edition,2014.
4. NPTEL Lecture Series on “Power Electronics” by Dr.B.G.Fernandes, IIT Bombay
5. Allan R. Hambley, “Electrical Engineering -Principles & Applications”, 2019, 6th Edition,Pearson Education
6. V. D. Toro, Electrical Engineering Fundamentals, 2nd edition. PHI, 2014
7. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition. Pearson, 2012

E-resources:

1. https://nptel.ac.in/courses/117106108
2. https://nptel.ac.in/courses/108106072
3. https://onlinecourses.nptel.ac.in/noc22_ee33/preview
4. https://onlinecourses.nptel.ac.in/noc23_ee105/preview
5. https://nptel.ac.in/courses/108102045

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the significance of electrical circuits, starter batteries, and the starting/charging system	PO1 (3), PO3 (2)	3	2
CO2	Apply principles of induction motors, including construction and speed control mechanisms	PO2 (3), PO3 (2)	3	2
CO3	Estimate the performance of power electronics devices like controlled rectifiers, AC controllers, and choppers	PO2 (3), PO3 (2)	3	2
CO4	Analyze the operation of various transducers and signal conditioning used in automotive systems	PO3 (3), PO5 (2)	3	3

AM25013	Application of AI and DS in Automotive Systems	L	T	P	C
		3	0	0	3

Course Objectives:

This course aims to equip students with the knowledge and skills to apply Artificial Intelligence (AI) and Data Science (DS) techniques in modern automotive systems. It focuses on the development of intelligent functionalities such as diagnostics, autonomous driving, and predictive maintenance using real-world vehicle data. Through hands-on simulations and case studies, students will learn to design, train, and implement AI/ML models that enhance vehicle performance, safety, and connectivity.

Introduction to AI & DS in Automotive Engineering

Overview of AI/ML/DL: relevance to automotive industry, Automotive electronics and embedded intelligence, Sensor types and automotive data sources: CAN, IMU, GPS, LIDAR, RADAR, Data pipelines: acquisition, cleaning, labeling, storage, Case study: data logging and pre-processing for vehicle telemetry.

Machine Learning for Vehicle Health Monitoring & Diagnostics

Supervised & unsupervised learning for fault detection, Predictive maintenance using time-series data, Feature engineering from vibration, engine, and ECU signals, Applications: anomaly detection in brakes, battery, HVAC, etc., Case study: ML-based fault prediction in electric vehicles (EVs).

Deep Learning in Autonomous and ADAS Systems

Neural networks for vision, localization, and control, CNNs for object detection: YOLO, SSD, Faster R-CNN, RNNs/LSTMs for behavior prediction and sensor fusion, End-to-end learning for self-driving systems, Case study: open-source datasets (KITTI, Waymo, CARLA).

AI for Connected Vehicles & Mobility Intelligence

V2X communication and edge AI, Telematics and fleet data analysis, Route optimization, traffic prediction, and smart navigation, Real-time data processing with Apache Kafka, Spark, Case study: AI-based ride-sharing and fleet optimization.

Tools, Platforms & Industry Applications

Tools, Edge AI devices (NVIDIA Jetson, Raspberry Pi) for in-vehicle ML, Integration with AUTOSAR and ISO 26262 safety standards, AI model validation and simulation using Carla, LGSVL, IPG CarMaker, Industry 4.0 applications in automotive manufacturing and quality.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology and weightage: Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)
References: 1. **Rajkumar et al.**, *"Principles of Autonomous Vehicle Design"*, Pearson, 2022 2. **S. Russell and P. Norvig**, *"Artificial Intelligence – A Modern Approach"*, Pearson 3. **Chanchal Chatterjee**, *"Applied Machine Learning for Smart Vehicles"*, Apress 4. **Russell, S., & Norvig, P.** – *Artificial Intelligence: A Modern Approach*, Pearson Education, 4th Edition, 2020 5. **Chanchal Chatterjee** – *Applied Machine Learning for Smart Vehicles*, Apress, 2020 6. **Zhang, Huiyu, & Liu, Zhihong** – *Deep Learning for Autonomous Vehicle Control*, Springer, 2021
E-Resources: https://www.udacity.com/course/self-driving-car-engineer-nanodegree--nd013 http://www.cvlibs.net/datasets/kitti/ https://www.tensorflow.org https://developer.nvidia.com/embedded-computing https://www.lgsvlsimulator.com https://www.ros.org https://www.autosar.org/standards/adaptive-platform https://www.iso.org/standard/68383.html https://colab.research.google.com

CO	CO Description	PO	PSO1	PSO2
CO1	Explain and identify AI/DS problems relevant to automotive systems	PO1 (3), PO3 (2)	3	2
CO2	Apply ML/DL techniques to build and train models using real vehicular data	PO2 (3), PO3 (2)	3	2
CO3	Estimate the performance of AI solutions in autonomous, connected, and diagnostic systems	PO2 (3), PO3 (2)	3	2
CO4	Analyze automotive datasets and simulation tools for testing and validation	PO3 (3), PO5 (2)	3	3

AM25014	Automotive Materials and Manufacturing	L	T	P	C
		3	0	0	3

Course Objectives:

This course provides an in-depth understanding of engineering materials and advanced manufacturing processes used in the automotive industry. It emphasizes material selection strategies, component-specific applications, and modern production technologies. Students will gain the ability to evaluate materials based on performance, sustainability, and manufacturability, and apply advanced manufacturing techniques including casting, forging, machining, and additive manufacturing to automotive components.

Engineering Materials and Their Properties

Classification and evolution of engineering materials. Mechanical, thermal, and environmental properties. Materials selection charts and performance indices. Drivers of change in material design and selection. Application-specific material selection

Principles of Material Selection and Design Integration

Material selection strategies and structural indices. Design process: functional, shape, and manufacturing considerations. Influence of processing methods on design and performance, Cost, energy, recyclability, and environmental impact. Computer-aided material selection

Materials for Powertrain and Transmission Systems

Materials for IC engine components: pistons, rings, cylinders, valves, crankshafts. Thermal and mechanical performance requirements, Materials for transmission systems: gears, clutches, turbochargers. Corrosion resistance, fatigue strength, and heat dissipation.

Materials for Automotive Structures and Electronic Systems

Materials for chassis, suspension, wheels, brakes, and body panels. Light weighting strategies using composites and advanced alloys. Fluids and elastomers for damping and friction control. Materials for electronic systems: sensors, ABS, airbags, lighting, and control units

Advanced Manufacturing Processes in Automotive Engineering

Casting techniques: sand, centrifugal, die, and investment casting. Machining processes: honing, grinding, 5-axis milling. Forging and extrusion: process flow, hydroforming, stretch forming. Powder metallurgy and plastic processing: injection, compression, PU foam molding. Emerging trends: additive manufacturing, plasma spraying, squeeze casting, rapid prototyping

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Kalpakjian, S., & Schmid, S. R. (2014). Manufacturing engineering and technology (7th ed.). Pearson Education.
2. Davies, G. (2003). Materials for automobile bodies. Butterworth-Heinemann.
3. Totten, G. E. (Ed.). (2004). Handbook of automotive engineering. ASME Press.
4. Strong, A. B. (2006). Fundamentals of composites manufacturing: Materials, methods and applications (2nd ed.). SME.
5. Groover, M. P. (2020). Fundamentals of modern manufacturing: Materials, processes, and systems (7th ed.). Wiley.
6. Friedrich, H. E., &Mordike, B. L. (2006). Magnesium technology: Metallurgy, design data, applications. Springer.
7. Chawla, K. K. (2012). Composite materials: Science and engineering (3rd ed.). Springer.

CO	CO Description	PO	PSO1	PSO2
CO1	Explain and identify automotive materials based on mechanical, thermal, and environmental criteria	PO1 (3), PO3 (2)	3	2
CO2	Analyze manufacturing processes and their impact on material performance and vehicle design	PO2 (3), PO3 (2)	3	2
CO3	Apply knowledge of composites and lightweight materials in automotive applications	PO2 (3), PO3 (2)	3	2
CO4	Evaluate sustainable and innovative solutions in material selection, production, and digital technologies	PO3 (3), PO5 (2)	3	3

AM25015	Motorsport Technology	L	T	P	C
		3	0	0	3

Course Objectives:

To impart in-depth knowledge of motorsport vehicle systems, including race car design, aerodynamics, chassis tuning, suspension setup, drive systems, and braking technologies with a focus on high-performance, safety, and regulation compliance.

Race Car Design and Development

Problems Imposed by Racing and Racing Objectives. Rulebook, Regulations, and Constraints. Road Car vs Race Car Comparison. Performance and Handling Specifications. Structure, Weight Distribution, and Driver Safety. Tire and Adjustable Features. Preliminary Design and Analysis. Driver-Vehicle Relationship and Desirable Characteristics.

Race Car Aerodynamics

Aerodynamic Forces and Moments. Race Car Drag Components and Estimation. Ground Effects and Ground Plane Simulation. Spoilers, Wings, and Effectiveness in Cornering. Flow Control Devices and Vortex Creation. Pressure Change Creation Devices. Full Size Wind Tunnel Testing.

Race Car Chassis

Conditions for Cornering and Chassis Tuning. Effects of High-Speed Braking, Cornering, and Combined Actions. Steady State Cornering and Acceleration. Straight Line Acceleration and Throttle Behavior. Moving CG Position and Roll Center. Anti-Pitch Geometry and Chassis Steering Axis. Chassis Ride Roll Characteristics and Track Width. Tires, Rims, and Roll Stiffness Adjustment.

Race Car Suspension System

Front Suspension Design and Performance Features. Camber Effects and McPherson Struts. SLA Suspension and Rear Suspension Types.F1 Car Suspension Configurations. Suspension Springs and Installation Considerations. Damping in Racing and Ride/Handling Compromise. Steering Activity and Bump/Rebound Damping. Chassis Track Width and Ride Spring Rate. Adjusting Roll Stiffness Distribution

Race Car Drives and Braking Systems

Front and Rear-Wheel Drive in Racing. Four-Wheel Drive and Differentials in Racing. Limited Slip Differential and Traction Control. Mechanical Components in Braking System. Limitations and Considerations of Braking in Racing. Brake Boost and Effects of "g" Force. Brake Hydraulics, Ventilation, and Distribution. ABS in Racing and Carbon-Carbon Discs.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem

(10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Adrian Newey, "How to Build a Car: The Autobiography of the World's Greatest Formula 1 Designer," HarperCollins, 2017.
2. Simon McBeath, "Competition Car Aerodynamics: A Practical Handbook," Haynes Publishing, 2014.
3. Brian Beckman, "Vehicle Dynamics: Theory and Application," Society of Automotive Engineers (SAE) International, 2013.
4. John Dixon, "Competition Car Composites: A Practical Handbook," Haynes Publishing, 2013.
5. Michael Costin and David Phipps, "Competition Car Chassis: Design, Structures, and Materials," Haynes Publishing, 2008.
6. Allan Staniforth, "Competition Car Suspension: Design, Construction, Tuning," Haynes Publishing, 2005.
7. David E. Hoyle, "ISO 9000 Quality Systems Handbook: Automotive Industry Edition," Butterworth-Heinemann, 2005.
8. Paul Van Valkenburgh, "Race Car Engineering & Mechanics," Bentley Publishers, 2001.
9. William F. Milliken and Douglas L. Milliken, "Race Car Vehicle Dynamics," SAE International, 1995.
10. Carroll Smith, "Tune to Win: The art and science of race car development and tuning," Aero Publishers, 1978.

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the fundamental challenges, performance requirements, and regulatory frameworks of race car design	PO1 (3), PO3 (2)	3	2
CO2	Apply aerodynamic principles and evaluate devices like wings, spoilers, and diffusers for performance	PO2 (3), PO3 (2)	3	2
CO3	Analyze chassis geometry, weight distribution, and structural design to optimize handling and safety	PO2 (3), PO3 (2)	3	2
CO4	Evaluate suspension configuration and tuning to improve ride stability, traction, and response	PO3 (3), PO5 (2)	3	3

AM25016	Noise, Vibration, and Harshness (NVH)	L	T	P	C
		3	0	0	3

Course Objectives:

At the end of the course students will be able to understand the different vehicle noise and vibration. To familiarise with the application of NVH refinement in vehicles and their systems. To introduce different techniques in reduction of NVH.

Introduction

Fundamentals of vibrations –Vibration of Single degree of freedom, Multi degrees of freedom – Vehicle vibration measurement and analysis Fundamentals of acoustics, Vehicle noise measurement, Noise Standards, Types of Signals, Signal conditioning and processing, Data Acquisition Systems, Analysis and presentation of data Ride Comfort –Sound Quality and psychoacoustics –Sound Quality Metrics, Subjective–objective correlation –Squeak and Rattle-Vibration isolation and Transmission.

Noise measurements and Instrumentation

Measuring microphones, Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Order analysis and waterfall plot, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Two-microphone probe for measuring; Sound power measurement from Sound Intensity

Vehicle Interior and Exterior noise

Internal noise sources in vehicles such as engine noise; road noise; aerodynamic (wind) noise; brake noise; squeak, rattle and tizz noises; sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions; Exterior noise sources in vehicles. such as air intake systems and exhaust systems; Tyre noise.

Sources of Vehicle Vibration:

Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness.

Vibration Measurement and Instrumentation

Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Transducers and accelerometers Excitation sources Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser-based vibration measurements; analysis and presentation of vibration data.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Bies D. A. and Hansen C. H., Engineering Noise Control: Theory and Practice-, Spon Press, Taylor &Francis, NYUSA, 2003.
2. Mathew Harrison, Vehicle Refinement- Controlling Noise & Road, Elsevier Publication, I st Edition, 2004
3. William W. Seto, Theory and Problems of Mechanical Vibrations, McGraw Hill International BookCo., Singapore, Illustrated Edition, 1964
4. S. S. Rao, Mechanical Vibrations, Pearson Education Inc., 5th Edition, 2010
5. S. Graham Kelly, Mechanical Vibrations, Schaum’s Outline Series, Tata McGraw Hill Publishing Co.Ltd. SI Edition, 2000

CO	CO Description	PO	PSO1	PSO2
CO1	Explain and understand the fundamentals of Noise, Vibration, and Harshness	PO1 (3), PO3 (2)	3	2
CO2	Apply instruments and techniques to analyze data for identifying noise and vibration sources	PO2 (3), PO3 (2)	3	2
CO3	Estimate and measure various noise sources in automotive systems	PO2 (3), PO3 (2)	3	2
CO4	Analyze sources of vehicle vibrations and evaluate their impact on performance	PO3 (3), PO5 (2)	3	3

AM25017	Reverse Engineering in Automobile Engineering	L	T	P	C
		3	0	0	3

Course Objectives:

This course introduces the principles and practices of reverse engineering in the automotive domain. Students will learn to deconstruct and analyze vehicle components, systems, and assemblies using modern tools such as 3D scanning, CAD modeling, and simulation. The course emphasizes innovation, design improvement, and digital reconstruction techniques to support product development, benchmarking, and remanufacturing.

Fundamentals of Reverse Engineering

Definition and scope of reverse engineering Applications in automotive design, diagnostics, and remanufacturing. Legal and ethical considerations Overview of reverse engineering workflow

Tools and Technologies for Reverse Engineering

3D scanning technologies: laser, structured light, photogrammetry, Coordinate Measuring Machines (CMM) and digitization techniques, Introduction to CAD software for reconstruction, Data acquisition and processing, Accuracy, resolution, and limitations of scanning tools

CAD Modeling and Digital Reconstruction

Surface and solid modeling techniques, Feature recognition and parametric modelling, Reverse modeling from point cloud data, Assembly reconstruction and tolerance analysis, Integration with PLM and digital twin systems.

Material and Manufacturing Analysis

Material identification techniques: spectroscopy, hardness testing, microscopy, Manufacturing process identification: casting, forging, machining, additive manufacturing, Failure analysis and wear pattern interpretation, Benchmarking and design optimization.

Applications and Future Trends

Reverse engineering for legacy parts and obsolete components, Applications in motorsport, restoration, and aftermarket design, AI and machine learning in pattern recognition and design automation, Sustainability and circular economy through remanufacturing, cloud-based reverse engineering, collaborative platforms.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Raja, V., & Fernandes, K. J. (2008). Reverse engineering: An industrial perspective. Springer.

2. Wego, W. (2013). 3D scanning: Principles and applications. Wiley.
3. Zeid, I. (2014). Mastering CAD/CAM. McGraw-Hill Education.
4. Chua, C. K., & Leong, K. F. (2017). 3D printing and additive manufacturing: Principles and applications (5th ed.). World Scientific.
5. ASTM International. (n.d.). Standards for reverse engineering and 3D scanning.

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the principles and applications of reverse engineering in automotive systems	PO1 (3), PO3 (2)	3	2
CO2	Apply 3D scanning and CAD tools to reconstruct and analyze vehicle components	PO2 (3), PO3 (2)	3	2
CO3	Estimate materials and manufacturing processes using analytical techniques	PO2 (3), PO3 (2)	3	2
CO4	Analyze reverse engineering results for design improvement and remanufacturing	PO3 (3), PO5 (2)	3	3

AM25018	Special Vehicles	L	T	P	C
		3	0	0	3

Course Objectives:

To provide students with comprehensive knowledge of the design, functionality, and applications of various earthmoving, constructional, agricultural, industrial, and military vehicles. The course emphasizes equipment classification, operational principles, selection criteria, and performance characteristics to prepare students for practical engineering roles in vehicle systems and machinery operations.

Earth Moving Equipments

Construction layout, capacity and applications of dumpers, articulated haulers, front- end loaders, backhoe loaders, bulldozers, scrappers, motor graders, skid-steer loaders, excavator, hydraulic shovels, bucket conveyors, surface miners–highwall Miners. Selection criteria of prime mover for dumpers.

Constructional Equipments

Construction layout, capacity and applications of cranes–types, Articulated Trucks, concrete ready mixer, trenchers, Asphalt Pavers, road reclaimers, Compactors–types, draglines, drillers, bore well machine.

Farm Equipmemts

Classification of tractors – Main components of tractor. Working attachment of tractors – Auxiliary equipment –-Top lifting harvesters. General description, working, specification and functions paddy harvesting machines, Sugarcane harvesting, feller bunchers, forest machines.

Industrial Vehicles

Constructional features, capacity and working of forklifts, Utility vehicles, towing vehicles, man-lift chassis, scissor lift trucks, material handlers, reclaimers, Street sweepers.

Military and Combat Vehicles

Special features and constructional details of Main Battle tank, gun carriers, transport vehicles, Armored vehicle – launched bridge, amphibious bridging vehicle, communication vehicles.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Abrosimov.K, Branberg.A.andKatayer.K., "Road making Machinery”, MIR Publishers, Moscow,1971.
2. Rodichev and G.Rodicheva, Tractor and Automobiles, MIR

Publishers,1987.
3. Wong.J "Theory of Ground vehicles", John Wiley &Sons, NewYork,1987.
4. B.Geleman and M.Moskovin, “Farm tractors”,MIR publishers, Moscow.
5. Bart H Vanderveen, “Tanks and Transport vehicles”, Frederic Warne and Co ltd., London.
6. Kolchin,A. and V.Demidov,” Design of Automotive Engines for Tractor”, MIR Publishers,1972.
7. Peurifoy R.L, “Construction Planning, Equipment and Methods”, Tata McGraw-Hill, NewDelhi,2002.
8. WongJ “Terramechanics and Off-Road Vehicle Engineering”, Butterworth-Heinemann, 2009

E-resources:

1. https://saemobilus.sae.org
2. https://www.deere.com
3. https://www.cat.com

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the constructional features and applications of earthmoving and construction equipment	PO1 (3), PO3 (2)	3	2
CO2	Apply knowledge to analyze working principles and attachments of farm machinery and harvesting systems	PO2 (3), PO3 (2)	3	2
CO3	Estimate operational capabilities and design aspects of industrial vehicles for material handling	PO2 (3), PO3 (2)	3	2
CO4	Analyze structural and functional characteristics of military and combat vehicles	PO3 (3), PO5 (2)	3	3

AM25019	Sustainable Automotive Technologies	L	T	P	C
		3	0	0	3

Course Objectives:

This course enables students to understand sustainability principles and their integration throughout the automotive design and development process. It focuses on analyzing electrified powertrains and alternative fuel systems for their environmental and operational advantages. Students will also evaluate advanced vehicle technologies and policy frameworks that support energy efficiency, emissions reduction, and global mobility objectives.

Introduction to Sustainability in The Automotive Sector

Principles of sustainability and life cycle thinking - Environmental impact of traditional automotive systems - Carbon footprint and GHG emissions of vehicles - Global and regional regulations (e.g., Euro 6, CAFE standards) - Role of automotive industry in climate change mitigation.

Electrification of Vehicles

Electric vehicles (EVs): Components and architecture - Types of EVs: BEVs, HEVs, PHEVs, FCEVs - Battery technology: Li-ion, solid-state batteries - Charging infrastructure and grid integration - EV performance, range, and lifecycle analysis.

Alternative Fuels and Powertrains

Biofuels (ethanol, biodiesel), hydrogen, synthetic fuels - Fuel cell technology and hydrogen economy - Natural gas vehicles (CNG, LNG) - Comparative emissions and efficiency of alternative fuels - Hybrid powertrains and energy recovery systems.

Light weighting and Sustainable Materials

Importance of vehicle weight reduction for fuel efficiency - Advanced materials: high- strength steel, aluminium, composites - Recycled and bio-based materials in automotive manufacturing - Design for disassembly and recyclability - Life cycle assessment (LCA) tools and case studies.

Intelligent Mobility and Future Trends

Connected and autonomous vehicles (CAVs) and their role in sustainability – Shared mobility and transportation-as-a-service (TaaS) - Smart traffic management and eco- routing - Urban mobility planning and sustainable transport systems - Future trends: solar vehicles, vehicle-to-grid (V2G), circular economy.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Ehsani, M., Gao, Y., Gay, S. E. and Emadi, A., “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC Press, Boca Raton, 2018.
2. Guzzella, L. and Sciarretta, A., “Vehicle Propulsion Systems: Introduction to Modeling and Optimization”, Springer, Berlin, 2013.
3. Chan, C. C. and Chau, K. T., “Modern Electric Vehicle Technology”, Oxford University Press, Oxford, 2001.
4. Larminie, J. and Dicks, A., “Fuel Cell Systems Explained”, Wiley, Chichester, 2003.
5. Speight, J. G., “Alternative Fuels for Transportation”, Butterworth-Heinemann, Oxford, 2016.

E-resources:

https://saemobilus.sae.org/?utm_source=chatgpt.com

CO	CO Description	PO	PSO1	PSO2
CO1	Explain and apply life cycle assessment (LCA) techniques to evaluate the environmental impact of vehicles	PO1 (3), PO3 (2)	3	2
CO2	Apply knowledge to compare performance, efficiency, and emissions of electric, hybrid, and fuel-cell vehicles	PO2 (3), PO3 (2)	3	2
CO3	Estimate the effect of automotive subsystems (lightweight structures, aerodynamic aids, regenerative systems) on sustainability	PO2 (3), PO3 (2)	3	2
CO4	Analyze and select suitable alternative fuels and powertrains for various transportation scenarios based on economic, environmental, and technical criteria	PO3 (3), PO5 (2)	3	3

AM25020	Vehicle Internet of Things	L	T	P	C
		3	0	0	3

Course Objectives:

This course introduces students to the fundamentals and applications of IoT in the automotive domain, focusing on connected vehicle systems. It covers key technologies such as in-vehicle sensors, communication protocols (CAN, LIN, V2X), cloud integration, and edge computing. Students will learn to analyze vehicle data, design secure IoT architectures, and explore real-time connectivity solutions. The course also highlights standards, cybersecurity, and trends like autonomous driving and smart mobility.

Introduction to IoT and Vehicle Connectivity

Definition and scope of IoT in automotive systems – Key technologies and protocols – Edge, fog, and cloud computing – Architecture of connected vehicles – Sensors and actuators in vehicular systems – Use cases: Telematics, infotainment, fleet management.

Vehicle Communication Technologies

V2X communication: V2V, V2I, V2P, V2N – DSRC and 5G-CV2X – CAN, LIN, Ethernet in vehicle networks – MQTT, CoAP, and HTTP for data transmission – Vehicle data buses and gateway design – Connected vehicle frameworks.

Embedded Systems and IoT Platforms

IoT hardware: microcontrollers (ARM, ESP32, STM32), Raspberry Pi – Sensor interfacing and ADCs – IoT platforms: AWS IoT, Google Cloud IoT, Azure IoT Hub – Real-time operating systems (RTOS) – Time synchronization and edge intelligence.

Data Acquisition, Analytics, and Applications

On-board diagnostics (OBD-II), telematics control units – Data logging, filtering, and preprocessing – Edge computing in vehicles – Data analytics for predictive maintenance, driver behavior analysis, traffic insights – Cloud dashboards.

Cybersecurity, Standards, and Future Trends

Automotive cybersecurity principles – Secure boot, encryption, authentication – Standards: ISO 21434, UNECE WP.29 – Privacy concerns and regulatory issues – Emerging trends: Digital twin, OTA updates, autonomous vehicle networks, AI integration.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology and weightage:

Assessment Exams (50%), Assignments/Case Study (20%), Quiz/Problem (10%),Virtual demonstration/Software Analysis (10%), Flipped Classroom (10%)

References:

1. Raj Kamal, Internet of Things: Architecture and Design, McGraw Hill Education, 2021.

2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2014.
3. Lingfeng Wang, Internet of Things for Smart Vehicles: Technologies and Applications, Springer, 2021.
4. Dietmar P.F. Möller and Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity, Springer, 2019.
5. Ovidiu Vermesan and Peter Friess, Internet of Things – From Research and Innovation to Market Deployment, River Publishers, 2014.
6. K. Krishnakumar, Connected Vehicles in the Internet of Things (IoT): Concepts, Technologies, and Applications, CRC Press, 2022.
7. Alice James, IoT in Automotive Industry: The Role of Connected Vehicles in Modern Transport Systems, Tech Press, 2020.

E-resources:

1. **ISO 26262 –** Road Vehicles: Functional Safety
2. **ISO 15118 –** Vehicle to Grid Communication Interface
3. **IEEE 802.11p –** Wireless Access in Vehicular Environments (WAVE)
4. **AUTOSAR –** Automotive Open System Architecture
5. **SAE J2735 –** Dedicated Short Range Communications (DSRC) Message Set Dictionary
6. **ISO/SAE 21434 –** Road Vehicles – Cybersecurity Engineering

CO	CO Description	PO	PSO1	PSO2
CO1	Explain the IoT architecture and its relevance to connected vehicle systems	PO1 (3), PO3 (2)	3	2
CO2	Apply knowledge to design vehicle communication frameworks using appropriate protocols	PO2 (3), PO3 (2)	3	2
CO3	Estimate performance of sensor and microcontroller interfaces for automotive IoT data acquisition	PO2 (3), PO3 (2)	3	2
CO4	Analyze cloud platforms, analytics tools, and security standards for real-world automotive IoT deployments	PO3 (3), PO5 (2)	3	3