

SEMESTER 3

AUTOMOBILE ENGINEERING

SEMESTER S3

MATHEMATICS FOR ELECTRICAL SCIENCE AND PHYSICAL SCIENCE – 3

(Common to B & C Groups)

Course Code	GYMAT301	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge in complex numbers.	Course Type	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. (Text 1: Relevant topics from sections 11.7, 11.8, 11.9)	9
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$. (Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)	9

3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of path, Cauchy integral theorem on multiply connected domain (without proof), Cauchy Integral formula (without proof). (Text 1: Relevant topics from sections 14.1, 14.2, 14.3)	9
4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $\cos\theta$ and $\sin\theta$. (Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)	9

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	K3
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	K3
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	K3
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10 th edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3 rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39 th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44 th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1 st edition, 2011

SEMESTER S3

FLUID MECHANICS AND HYDRAULIC MACHINES

Course Code	PCAUT302	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the fundamental concepts, pressure measurement techniques and stability of fluids.
2. Apply fluid mechanics principles to practical applications.
3. Understand the mechanics of fluid flow through pipes and impact of jet flows to enhance knowledge in engineering applications.
4. Analyse the performance and efficiency of various hydraulic machines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamental concepts: Properties of fluid - density, specific weight, viscosity, surface tension, bulk modulus, compressibility, velocity, rate of shear strain, Newton's law of viscosity, Newtonian and non-Newtonian fluids, real and ideal fluids, incompressible and compressible fluids. Fluid statics: Atmospheric pressure, gauge pressure and absolute pressure. Pressure at a point in a fluid, Pascal's law. Measurement of pressure - piezometer, manometers, pressure gauges. Stability of bodies, buoyancy, metacenter, center of pressure.	11
2	Fluid flow: Energies in flowing fluid, head - pressure, dynamic, static and total head, continuity equation, Eulers equation, Bernoulli's	11

	equation with assumptions, practical applications. Flow rate measurements: Venturi and orifice meters, Notches and Weirs (description only). Velocity measurements- Pitot tube and Pitot –static tube.	
3	Flow through pipes: Reynolds experiment, Reynolds number, Laminar and Turbulent flow, boundary layer formation, developing and fully developed flow, Navier-Stokes equation (no derivation), Hagen-Poiseuille equation, head loss due to friction, friction factor, Mody's chart, Darcy-Weishbach equation, Chezy's formula, Major and Minor losses in pipes Impact of jets: Stationary and moving vanes – Flat and curved vanes, work done and efficiency	11
4	Turbines : Impulse and Reaction Turbines – Pelton Wheel – Constructional features - velocity triangles, speed ratio, jet ratio & work done, losses and efficiencies, Francis Turbine – velocity triangles, work done and efficiencies. draft tubes – surge tanks – cavitation in turbines – governing of turbines – specific speed of turbine. Pumps: Positive displacement pumps- reciprocating pumps – air vessels and their purposes – slip, negative slip and work done and efficiency- indicator diagram- effect of acceleration and friction on indicator diagram. Gear pump, vane Pump, lobe pump. Rotodynamic pumps- centrifugal pump-impeller, casings –velocity triangle, work done, efficiency and losses, priming, cavitation, specific speed. Performance characteristics- Multi stage pumps.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts, pressure measurement techniques and stability of fluids.	K2
CO2	Explain the principles of fluid mechanics and its relevance to practical applications.	K2
CO3	Understand the mechanics of fluid flow through pipes and the impact of jet flows to enhance comprehension of engineering applications.	K2
CO4	Explain the performance and efficiency of various hydraulic machines.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	3										
CO3	3	3										
CO4	3	2										
CO5												

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics: Fundamentals and Applications	John. M. Cimbala, Yunus A. Cengel	Tata McGraw-Hill	4th Edition &2018
2	Fluid Mechanics	Frank M. White	McGraw-Hill	8th Edition, 2015
3	A Textbook of Fluid Mechanics	R.K. Bansal	Laxmi Publications	9th Edition, 2018
4	Fluid Mechanics and Hydraulic Machines	R.K. Rajput	McGraw-Hill	5th Edition, 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Fluid Mechanics	Robert W. Fox, Alan T. McDonald, and Philip J. Pritchard	John Wiley & Sons	8th Edition, 2011
2	Fluid Mechanics: Including Hydraulic Machines	A.K. Jain	Khanna Publishers	8th Edition, 2014
3	Hydraulics and Fluid Mechanics Including Hydraulic Machines, 2013	S. Ramamrutham	Dhanpat Rai Publishing Company	9th Edition, 2013
4	Introduction to Fluid Mechanics and Fluid Machines 3rd Edition	S K Som Gautam Biswa, S Chakraborty		3rd Edition, 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Introduction and Fundamental Concepts – Prof. S Chak , IIT, Kharagpur https://archive.nptel.ac.in/courses/112/105/112105269/
2	Fluid Machines – Prof. Suman Chakraborty, IIT, Kharagpur, https://archive.nptel.ac.in/courses/112/105/112105206/

SEMESTER S3

AUTOMOTIVE CHASSIS

Course Code	PCAUT303	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the fundamental principles and constructional details of various automotive chassis components.
2. Impart basic knowledge of different types of drivetrains and axles.
3. Understand the operation of suspension, brakes, wheels, and tyres.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Chassis and Frames: Types of chassis layouts with reference to power plant location & drive. Automotive frames: Constructional details & various types - four wheeler and two wheeler frames, frame materials, loads acting on the frames, defects and remedies. Suspension System: Need for suspension system, constructional details and characteristics of suspension springs - single leaf, multi Leaf, coil, torsion bar, rubber, pneumatic and hydro-elastic. Rigid axle suspension system, independent suspension system-types. Shock absorbers-types and construction.	11
2	Front axle and Steering: Front axles and stub axles, steering geometry parameters- significance and effects, conditions for true rolling, steering linkages, steering mechanisms, types of steering gear box- recirculating ball type, rack and pinion. Steering ratio, reversibility, wheel alignment,	11

	power steering system – integral and linkage, power assisted steering.	
3	Drive train: Propeller shaft, constructional details, universal joints & constant velocity joints, final drive - types, hotchkiss drive, torque tube drive, radius rods, pan hard rods and stabilizers. Differential - working principle and constructional details, non-slip differential & differential locks. Rear axles: Rear axles - live and dead axles, constructional details, loads acting on drive axles, rear axle shaft supporting types - semi floating, full floating, three quarter floating, axle housings and types, multi axle vehicle.	11
4	Brakes: Principle, stopping distance & braking efficiency, weight transfer during braking, drum brakes. Constructional details, leading and trailing shoe, braking torque. Disc brakes, types, constructional details, advantages & disadvantages, hydraulic, pneumatic & power-assisted braking systems, servo brakes, retarders- types. Wheels: Construction and function, classification, wheel dimensions. Tyres: Structure and function of tyres, classification, static and dynamic properties of pneumatic tyres, tyre materials, tyre section & designation, factors affecting tyre life, tyre rotation , wheel balancing , quick change wheels & special wheels.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To analyze and evaluate different chassis layouts and suspension systems, understanding their construction, materials, and performance characteristics.	K2
CO2	To understand and analyze steering geometry, mechanisms, and systems, including power-assisted steering and wheel alignment.	K2
CO3	To understand and analyze the construction and functioning of various drivetrain components and rear axle configurations in automotive vehicles.	K2
CO4	To understand and evaluate the principles, construction, and performance of various braking systems, wheels, and tyres in automotive vehicles.	K2
CO5	To analyze and evaluate different chassis layouts and suspension systems, understanding their construction, materials, and performance characteristics.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Chassis Systems	K. V. James, D. Halderman	Prentice Hall	2013
2	Automobile Engineering-Vol1	Dr. Kirpal Singh	Standard Publishers and distributors	2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Automotive Technology	James E Duffy	Good Heart - Willcox	9th Edition(2017)
2	Automotive Technology	Jack Erjavec	Delmar Cengage learning	2009
3	Automotive Mechanics	William H. Crouse and Donald L	Mc Graw- Hill	10th edition(2007)

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	NPTEL – Fundamentals of Automotive Systems https://archive.nptel.ac.in/courses/107/106/107106088/
2	
3	

SEMESTER S3

MATERIAL SCIENCE AND METALLURGY

Course Code	PBAUT304	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. **Understand Atomic and Crystalline Structures:** Students will learn the characteristics of different atomic bonds and crystal structures and how these influence material properties and applications.
2. **Analyse Material Microstructures and Defects:** Students will explore various modes of deformation, crystallization effects and the role of crystal imperfections in determining the mechanical properties of materials.
3. **Apply Principles of Phase Transformations and Alloy Design:** Students will gain knowledge of phase diagrams, heat treatment processes, alloying principles and the behaviour of advanced materials under different conditions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Materials: Atomic structure and bonding characteristics of covalent, ionic and metallic bonds. Properties based on atomic bonding (Briefly), secondary bonds, classification and applications. Crystallography: Crystal structures: SC, BCC, FCC, HCP (brief description). Atomic packing factor (APF), Miller Indices: crystal plane and direction. Analysis of Microstructure: X-ray diffraction (XRD) with simple	9

	problems, Scanning electron microscopy (SEM) and Transmission electron microscopy (TEM). <i>Suggestion - Problem Project - Students can choose their focus areas, such as investigating different crystal structures, analyzing atomic packing factors, or exploring the applications of X-ray diffraction, SEM, and TEM in material science.</i>	
2	Deformation and Crystallization: Deformation and crystallization, modes of plastic deformation, slip and twinning, Schmid's law, crystallization, effects of grain size, Hall-Petch theory (simple problems), crystal imperfections, classification of crystal imperfections (point, line, surface). Dislocations: Burgers vector, Frank-read source, correlation of dislocation density with strength and the concept of nanomaterials, grain boundaries, high and low angle boundaries, driving force for grain growth, applications, characterization techniques, polishing and etching. <i>Suggestion - Discipline Project- Allowing students to explore specific aspects of microstructure and defects, such as slip, twinning, grain size effects, or dislocation density, within a defined overall theme.</i>	9
3	Phase Transformations: Constitution of alloys, solid solutions, substitutional and interstitial phase diagrams, isomorphous, eutectic, eutectoid, peritectic and peritectoid reactions, Iron-carbon equilibrium diagram. Classification of steel and cast iron microstructure, properties and application. Heat Treatment: Time-temperature-transformation (TTT) and Continuous cooling transformation (CCT) diagrams with applications, tempering, hardenability and Jominy end quench test, surface hardening methods.	9

	<i>Suggestion - Problem Project - independently explore phase transformations, heat treatment processes, and the practical applications of TTT and CCT diagrams.</i>	
4	Alloys: Need for alloying, classification of alloys, Hume-rothery rules. Equilibrium diagrams of common binary systems (five types), coring, lever rule, and Gibbs' phase rule. Strengthening mechanisms, cold working and hot working. Fatigue: Mechanism, factors affecting fatigue life, fatigue test, S-N curve, endurance limit, methods to improve fatigue life and thermal fatigue. Advanced Materials: Composite materials, bio-materials, super alloys, smart materials and nano materials. <i>Suggestion - Problem Project - independently explore alloy classifications, strengthening mechanisms, and advanced materials such as composites, biomaterials, and nanomaterials.</i>	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1	Internal Examination- 2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the characteristics of covalent, ionic, and metallic bonds, and their influence on material properties.	K2
CO2	Apply Schmid's Law to analyse the deformation behaviour of crystalline materials under different stress conditions.	K3
CO3	Understand the Fe-C phase diagram and the principles of phase transformations in alloys.	K2
CO4	Apply the lever rule and Gibbs' phase rule to interpret equilibrium diagrams of common binary systems and predict phase compositions.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3	3									
CO3	3											
CO4		3	3									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Material Science and Metallurgy	Name of the Author: O.P. Khanna	Dhanpat Rai Publications	17th Edition, 2015
2	Materials Science and Engineering: A First Course	V. Raghavan	Prentice Hall India Learning Private Limited	5th Edition, 2004
3	Introduction to Physical Metallurgy	Sidney H. Avner	Tata McGraw-Hill Education	2nd Edition, 1997
4	Mechanical Metallurgy	George E. Dieter	Tata McGraw-Hill Education	3rd Edition, 2013
5	Heat Treatment: Principles and Techniques	T. V. Rajan, C. P. Sharma, and Ashok Sharma	Prentice Hall India Learning Private Limited	2nd Edition, 2012
6	Phase Transformations in Metals and Alloys	David A. Porter, Kenneth E. Easterling, M. Y. Sherif	CRC Press	3rd Edition, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Materials Science and Engineering	William F. Smith, Javad Hashemi	McGraw-Hill Education	5th Edition, 2021
2	Physical Metallurgy: Principles and Practice	Raghavan	PHI Learning Private Limited	2nd Edition, 2006
3	Engineering Physical Metallurgy and Heat Treatment	Y. Lakhtin and V. Livshits	Mir Publishers	3rd Edition, 1989
4	Fundamentals of Creep in Metals and Alloys	Michael E. Kassner	Elsevier Science	3rd Edition, 2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Material Science and Engineering, IIT Roorkee, Dr. Vivek Pancholi https://nptel.ac.in/courses/113107078
2	
3	Introduction to Materials Science and Engineering, IIT Delhi, Prof. Rajesh Prasad https://archive.nptel.ac.in/courses/113/102/113102080/
4	Heat Treatment and Surface Hardening – II, IIT Kanpur, prof. Kallol Mondal, prof. sandeep sangal https://archive.nptel.ac.in/courses/112/104/112104219/

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	GNEST305	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to AI and Machine Learning: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	11

2	Mathematical Foundations of AI and Data science: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	11
3	Applied Probability and Statistics for AI and Data Science: Basics of probability-random variables and statistical measures - rules in probability-Bayes theorem and its applications- statistical estimation-Maximum Likelihood Estimator (MLE) - statistical summaries- Correlation analysis-linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	11
4	Basics of Data Science: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.)(Text book-5)	11

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	K3
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems.	K3
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	K3
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6 th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2 nd edition, 2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1 st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9 th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1 st edition, 2016

Reference Books				
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2 nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1 st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1 st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1 st edition, 2019
5	Probability and Statistics - The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1 st edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	Chrome extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.math.arizo	Preliminary Edition.

Video Links (NPTEL, SWAYAM...)

Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with an understanding of fundamental economic principles essential for effective decision-making in engineering contexts.
2. To enable students to apply economic analysis to production decisions, cost management, and market strategies in engineering practice.
3. To equip students with the ability to evaluate macroeconomic scenarios, financial methods, and investment decisions relevant to engineering projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility –Demand: Factors determining demand – Law of Demand – Demand curve- Price elasticity of demand- measurement of price elasticity and its applications – Supply: factors determining supply - Law of supply – Supply curve- Equilibrium price determination- Changes in demand and supply and its effects on equilibrium price and quantity Production: Production function - Law of variable proportion –Returns to scale- Cobb-Douglas Production Function	6
2	Cost: Cost concepts – Private cost and social cost – Sunk cost – Opportunity cost -Explicit and implicit cost –Short run cost curves –Long run average cost curve -Revenue concepts – Break-even point Market: Perfect Competition – Monopoly - Monopolistic Competition (features and equilibrium of a firm) - Oligopoly – Features – Kinked demand model	6

3	National income: Concepts (GDP, GNP and NNP)– Final goods and Intermediate goods - Methods of Estimation –output method – expenditure method-- Difficulties in the measurement of national income. Inflation: Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Repo and reverse repo rate	6
4	Value Analysis and value Engineering: Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure Capital Budgeting: Time value of money - Net Present Value Method - Benefit Cost Ratio – Internal Rate of Return – Payback – Accounting Rate of Return.	6

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems and national income.	K2
CO4	Make use of the possibilities of value analysis and engineering, and take investment decisions through capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012
4	Financial Management	I M Pandey	Vikas Publishing House	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001
5	Financial Management: Theory and Practice	Prasanna Chandra	Mc Graw Hill	2007

MODEL QUESTION PAPER				
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY				
THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH AND YEAR				
Course Code: UCHUT346				
Course Name: Economics for Engineers				
Max. Marks: 50			Duration: 2 hours 30 minutes	
	PART A			
		Answer all questions. Each question carries 3 marks	CO	Marks
1		What are the central problems of an economy?	CO1	(3)
2		Point out any three applications of price elasticity of demand.	CO1	(3)
3		What is the social cost of production?	CO2	(3)
4		What is repo rate?	CO3	(3)
5		What is esteem value?	CO4	(3)
6		Write a short note on time value of money.	CO4	(3)
PART B				
Answer any one full question from each module. Each question carries 8 marks				
Module 1				
9	a)	Suppose a country is producing at a point inside the production possibility curve. Draw a PPC and examine this situation.	CO1	(5)
	b)	State the law of demand. Point out any two exceptions of this law.	CO1	(3)
10	a)	A consumer purchases 10 units of a commodity when its price is Rs.100. Later when its price falls to Rs.90, he purchases 8 units only. Estimate price elasticity. What type of a commodity is this?	CO1	(5)
	b)	State the law of variable proportion.	CO1	(3)

Module 2				
11	a)	What is oligopoly? Why price is rigid under oligopoly?	CO2	(5)
	b)	The cost function of a firm is given as $TC=1000+10Q-6Q^2+Q^3$. Calculate fixed cost, variable cost and marginal cost when output is 10 units.	CO2	(3)
12	a)	Suppose a firm is earning super normal profit under monopolistic market condition. Explain this situation by drawing a diagram.	CO2	(5)
	b)	Suppose a firm sells its product at a price of Rs.10 per unit and its average variable cost is Rs.6. If the firm spend Ra.10000 as rent and pay Rs. 6000 as interest every month, estimate its break-even level of output.	CO2	(3)
Module 3				
13	a)	What is inflation? How does inflation affect investment and production.	CO3	(5)
	b)	How will you obtain NNP _{fc} from GDP _{mp} .	CO3	(3)
14	a)	From the data given below (In Rs. Crores) estimate GDP _{mp} and national income. Private final consumption expenditure = 1000, Government expenditure = 500, Invest expenditure = 700, Net exports = 300, Depreciation = 200, NFIA=(-200) and Net indirect tax = 100	CO3	(5)
	b)	What is bank rate? Examine the bank rate policy of the government during inflation.	CO3	(3)
Module 4				
15	a)	Examine the procedures of value engineering.	CO4	(5)
	b)	Examine the application areas of value engineering	CO4	(3)

16	a)	1. Suppose the initial investment of a project is Rs. 3000 (Crores) and the cost of capital or the opportunity cost of capital is 10 percent. Calculate NPV of the project based on the cash flows given below. Year 1 2 3 4 5 Cash flow 1000 900 800 700 600 (In Crores)	CO4	(5)
	b)	Point out any three merits of NPV method.	CO4	(3)

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism , Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution -Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places -accessibility and social impacts, Managing conflict , Collective bargaining, Confidentiality , Role of confidentiality in moral integrity, Codes of Ethics . Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education , employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in connection with	6

	gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives.	
2	Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	6
3	Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	6

Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks			50	

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER: S3

FLUID MECHANICS AND MACHINERY LAB

Course Code	PCAUL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To equip students with the ability to experimentally determine and analyse key hydraulic coefficients and discharge rates in various fluid flow measuring devices such as notches, orifice meters, and Venturi meters.
2. To enable students to understand and evaluate the performance and efficiency of different hydraulic machines, including pumps and turbines, under various operating conditions.
3. To develop practical skills in assessing and mitigating fluid flow losses, and to deepen the comprehension of fundamental fluid mechanics principles through hands-on experimentation.

Expt. No.	Experiments
1	Determination of coefficient of discharge and calibration of Rectangular Notch.
2	Determination of coefficient of discharge and calibration of V- Notch.
3	Determination of coefficient of discharge and calibration of Orifice meter.
4	Determination of coefficient of discharge and calibration of Venturi meter.
5	Determination of hydraulic coefficients of orifices.
6	Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus.
7	Determine the minor losses in pipe.
8	Experiments on hydraulic ram.
9	Reynolds experiment.
10	Bernoulli's experiment.
11	Determination of metacentric height and radius of gyration of floating bodies.
12	Performance test on positive displacement pumps.

13	Performance test on centrifugal pumps, determination of operating point and efficiency.
14	Performance test on gear pump.
15	Performance test on Impulse turbines.
16	Performance test on reaction turbines (Francis and Kaplan Turbines).
17	Speed variation test on Impulse turbine.
18	Determination of best guide vane opening for Reaction turbine.
19	Impact of jet.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and describe various types of fluid flow measuring devices and their applications in hydraulic systems.	K1
CO2	Recall the fundamental principles of fluid mechanics, including Bernoulli's principle and the laws governing fluid flow in pipes and open channels	K1
CO3	Understand the operational principles of positive displacement and centrifugal pumps, including the factors affecting their efficiency and performance.	K2
CO4	Explain the concepts of hydraulic coefficients, such as the coefficient of discharge, and how they are determined for different flow measuring devices.	K2
CO5	Will apply experimental procedures to determine Chezy's constant, Darcy's coefficient, and minor losses in pipe systems, and utilize these values in practical fluid flow calculations.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				2							
CO2	3											
CO3	3	2			2							
CO4	3	2		2								
CO5	3	3	2	3	2							

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics and Hydraulic Machines	Bansal R.K,	Laxmi Publications	2023
2	Hydraulics and Fluid Mechanics Including Hydraulic Machines	Modi P.N and Seth S.M	Standard Book House, New Delhi	22 nd Edition - 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics-Fundamentals and Applications	Yunus A. Cengel, John M. Cimbala	McGraw Hill,	2019
2	Engineering Fluid Mechanics	Graebel. W. P	Taylor & Francis, Indian Reprint,	2011
3	Fluid Mechanics and Machinery	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard,	John Wiley and sons.	2015
4	Fluid Mechanics with Engineering Applications	J. Fraabzini,.	McGraw Hill,	-

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Fluid Mechanics Laboratory https://archive.nptel.ac.in/courses/112/106/112106311/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER: S3

VEHICLE SYSTEMS LAB

Course Code	PCAUL308	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To provide students with hands-on experience in disassembling, inspecting, servicing, and reassembling various engine components and systems, ensuring they understand the mechanical intricacies and standard specifications of vehicle engines.
2. To equip students with the practical skills necessary for diagnosing, maintaining, and adjusting critical vehicle systems such as the clutch, gear box, differential assembly, and steering mechanisms, ensuring optimal performance and safety.
3. To enable students to proficiently perform and interpret diagnostic tests and measurements, such as compression tests, emission checks, wheel alignment, and tire balancing, using specialized tools and equipment to meet industry standards.

Expt. No.	Experiments
1	Disassembling cylinder head, decarbonizing- Valve timing setting including valve clearance adjustment.
2	Compression test of petrol , diesel engine
3	Disassembling of engine: inspection of engine components, servicing of components, piston ring setting using special tools
4	Engine Valve reconditioning: Valve grinding by using valve re-facing machine, valve seat grinding, lapping and valve angle cutting.
5	Checking the emission of gasoline engine with exhaust gas analyser and Checking the emission of diesel engine with diesel smoke meter.
6	Cylinder reconditioning: Checking the cylinder bore, setting the tool, re-boring operation using vertical cylinder reboring machine.
7	Cylinder liners setting of engine using hydraulic press , Line boring: measure bore , setting bore , Setting the tool, line boring using horizontal line boring machine

8	Servicing of clutch assembly
9	Dismantling of differential assembly, servicing, backlash adjustments, check for drive axis ratio.
10	Dismantling of gear box, inspecting components, servicing, checking the gear ratios.
11	Study of steering system. Servicing of steering gear box, checking for end play in shafts.
12	Servicing master and wheel cylinders in hydraulic brake system & bleeding of brakes.
13	Tyre codes , Tyre removing, inspection, check for cuts, bulges and excessive tread wear, resetting using pneumatic tyre changer
14	Wheel balancing: Balancing of wheels by computerized wheel balancing machine.
15	Wheel alignment: Checking the camber, caster, king pin inclination, toe in and toe out with computerized wheel alignment machine.

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and recall the various components of a vehicle's engine and their respective functions.	K1
CO2	Remember the standard procedures for disassembling and servicing key vehicle systems such as the differential assembly and hydraulic brake system.	K1
CO3	Understand the operational principles and servicing techniques for vehicle systems, including valve timing, gear ratios, and clutch assemblies	K2
CO4	Comprehend the methods for performing and interpreting diagnostic tests on vehicle engines, such as compression tests and emission checks.	K2
CO5	Apply appropriate tools and procedures to disassemble, inspect, and reassemble various vehicle systems, ensuring components meet standard specifications and proper functioning.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2							
CO2	3	-	-	-	-							
CO3	3	2	-	-	2							
CO4	3	2	-	2	-							
CO5	3	3	2	3	2							

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Engineering, Vol 1	Dr Kripal Singh	Standard Publishers distributors	Dec 2020
2	Automobile Engineering , Vol 2	Dr Kripal Singh	Standard Publishers distributors	Dec 2020
3	Automobile Engineering Practical	N Malhotra	Asian Publishers	Jan 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Vehicle service manuals of reputed manufacturers.			
2	Automotive Mechanics	William H Crouse Donald L Anglin,	Tata Mcgraw Hill Publishing	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Fundamentals of Automotive Systems - https://archive.nptel.ac.in/courses/107/106/107106088/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 4

AUTOMOBILE ENGINEERING

SEMESTER S4
MATHEMATICS FOR PHYSICAL SCIENCE – 4

Course Code	GCMAT401	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic calculus.	Course Type	Theory

Course Objectives:

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To provide the students with the basics of various numerical methods to develop problem solving skills used in various engineering disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. [Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]	9
2	Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. [Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1,5.2]	9

3	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and <i>t</i> -distribution), Hypotheses and Test Procedures, Type I and Type II error, <i>z</i> Tests for Hypotheses about a Population Mean (for large sample), <i>t</i> Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. [Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]	9
4	Newton-Raphson Method, Gauss Elimination Method, Gauss - Jordan Method, Numerical solution of ordinary differential equations-Euler's method, Modified Euler's method, Runge - Kutta method of 2 nd Order, Numerical solution of Laplace equation –Jacobi's Method, Curve Fitting by Method of Least Squares - Straight lines, Parabola. (Text 2: Relevant topics from sections 2.5, 4.2, 7.5, 8.4, 8.5, 9.4)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	K3
CO2	Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	K3
CO3	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z -tests and the one-sample t -test.	K3
CO4	Apply numerical methods to find solutions of linear system of equations, ordinary differential equations and Laplace equations.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9 th edition, 2016
2	Introductory Methods of Numerical Analysis	S S Sastry	PHI Learning Pvt Limited	5 th edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill.	4 th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6 th edition, 2020
3	Numerical methods for Engineers	Steven C. Chapra, Raymond P. Canale	McGraw Hill Education	8 th edition, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/117/105/117105085/
2	https://archive.nptel.ac.in/courses/117/105/117105085/
3	https://archive.nptel.ac.in/courses/117/105/117105085/
4	https://archive.nptel.ac.in/courses/111/107/111107105/

SEMESTER S4
MECHANICS OF SOLIDS

Course Code	PCMUT402	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To acquaint with the basic concepts of stress and deformation in solids.
2. To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to analysis of deformable bodies. Types of external loads - Normal, Shear, Bending and Bearing stress- Linear and Shear strains. Hooke's law - Stress-Strain diagrams - concepts of Isotropy, Orthotropy, Anisotropy. Young's Modulus, Bulk Modulus and Rigidity Modulus. Poisson's ratio - Relationship between elastic constants. Deformation in axially loaded bars –uniform cross section, varying cross section, dissimilar materials, principle of superposition. Thermal effects – simple, composite bars.	11
2	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – shaft design for torsional load. Beams- Classification - Diagrammatic conventions for supports and loading – Differential equations between load, Shear Force and Bending Moment- Shear Force and Bending Moment Diagrams of Cantilever and Simply supported beam with Point load/UDL. Point of Inflection.	11

3	Stresses in Beams: Pure Bending – Flexure formula for beams - assumptions and limitations – Section Modulus - Flexural Rigidity Shearing Stress formula for beams – Shear stress distribution in beam section - derivation and problems for rectangular section only – assumptions and limitations Deflection of Beams: Moment-Curvature relation – assumptions and limitations - Double Integration method – Macaulay's method	11
4	Stress on an inclined plane due to Uniaxial stress- Stress on an inclined plane due to Biaxial stress- Stress on an inclined plane due to two Normal Stresses accompanied by Shear stresses- principal planes and stresses. Mohr's circle of stress. Buckling and stability of long columns-Euler's buckling/crippling load for columns with different end conditions- Euler equation derivation for both ends hinged only- Rankine's formula	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the stresses and strains in deformable bodies subjected to different types of external loads and thermal effects	K3
CO2	Analyse the torsion of circular bars and draw the shear force and bending moment diagrams for beams	K4
CO3	Determine the stresses and deflections in beams subjected to transverse loads	K3
CO4	Determine analytically and graphically the principal stresses and planes for structural members subjected to loads and analyse the strength of columns	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	3	2									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Solids	R.K.Bansal	Laxmi Publications	2012
2	Mechanics of Solids	S. S. Bhavikatti	New Age International	2013
3	Strength of Materials	Surendra Singh	S. K. Kataria & Sons	2013
4	Strength of Materials	Rattan	McGraw Hills	2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of materials	R. C. Hibbeler	Pearson Higher Education	2018
2	Engineering Mechanics of Solids	Popov E	PHI	2002
3	Mechanics of Materials	Beer & Johnston	McGraw Hills	2017
4	Mechanics of Materials	Pytel A. and Kiusalaas J.	Cengage Learning India Private Limited,	2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_ce46/preview
2	https://onlinecourses.nptel.ac.in/noc22_ce46/preview
3	https://onlinecourses.nptel.ac.in/noc22_ce46/preview
4	https://onlinecourses.nptel.ac.in/noc22_ce46/preview

SEMESTER S4

THERMODYNAMICS AND HEAT TRANSFER

(Branch - AU - Group - C)

Course Code	PCAUT403	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand thermodynamic fundamentals and laws of thermodynamics, including energy transformations and system properties.
2. Apply first and second laws to evaluate cycles, processes, and heat transfer in various systems.
3. Understand and apply conduction, convection, and radiation principles in designing heat exchangers and thermal systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts in Thermodynamics: Basic concepts of thermodynamics - Thermodynamics systems- Properties of a system - State and equilibrium - Processes and cycles - Work and heat transfer - Temperature and Zeroth law of thermodynamics. First law of Thermodynamics: First law for a closed system undergoing a cycle-Enthalpy- specific heats PMM1, first law of thermodynamics for steady flow process, SFEE	11

2	Second Law of Thermodynamics: Kelvin-Planck and Clausius statements and its equivalence - Refrigerators, heat pump–COP – PMM II - Reversible and irreversible process Carnot’s theorem - Entropy - The Clausius inequality - Availability and irreversibility. Pure Substances: Pure substances, phase transformations, triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, saturation pressure and temperature, T-h and T-s diagrams, h-s diagrams or Mollier charts, steam tables. Property calculations using steam tables.	11
3	Mixtures of ideal Gases: Mole Fraction, mass fraction, Dalton’s law of partial pressure, Amagat’s laws of additive volumes, Gibbs-Dalton’s law, equivalent gas constant and molecular weight, properties of gas mixtures, internal energy, enthalpy, specific heats and entropy, introduction to real gas mixtures-Kay’s rule. General Thermodynamic Relations: Combined first and second law equations – Helmholtz and Gibb’s functions - Maxwell’s relations, Tds equations (Derivations not required). The clapeyron equation throttling process, Joule thomson coefficient, inversion curve.	11
4	Fundamentals of Heat Transfer: Overview of conduction, convection and radiation-Fourier’s law of heat conduction (1 dimensional only). Thermal conductivity of materials, basics of convective heat transfer, Newton’s law of cooling (1 dimensional only). Radiation: Basic concepts of thermal radiation, blackbody radiation and emissive power, Stefan-boltzmann law and Planck’s Law. Heat Exchangers: Introduction and types of heat exchangers-parallel flow and counter-flow heat exchangers. Concept of overall heat transfer coefficient using LMTD and NTU methods.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental thermodynamic principles, including system properties, equilibrium states, work, heat transfer, and the first law for closed and steady flow processes.	K 2
CO2	Apply the second law of thermodynamics to analyze refrigerators, heat pumps, and thermodynamic cycles, and understand properties and phase transformations of pure substances using diagrams and steam tables.	K 2
CO3	Understand gas mixture behavior and apply thermodynamic relations to solve problems with real gas mixtures, including the Clapeyron equation and the Joule-Thomson effect	K 2
CO4	Understand heat transfer processes (conduction, convection, radiation) and design heat exchangers, evaluating their performance using LMTD and NTU methods.	K 2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1								
CO2	3	3	2	1								
CO3	3	2	3									
CO4	2	3	1									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Thermodynamics	P.K. Nag	McGraw-Hill Education	6th Edition, 2017
2	Thermodynamics: An Engineering Approach	Yunus A. Çengel, Michael A. Boles.	McGraw-Hill Education	9th Edition, 2019
3	Fundamentals of Thermodynamics	Richard E. Sonntag, Claus Borgnakke, Gordon J. VanWylen	Wiley	8th Edition, 2014
4	Heat Transfer: Principles and Applications	B.K. Rajput	S. Chand & Company Ltd	10th Edition, 2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Engineering Thermodynamics	Michael J. Moran, Howard N. Shapiro	Wiley	9th Edition, 2018
2	Thermodynamics and Heat Power	Kurt C. Rolle	Prentice Hall	8th Edition, 2015
3	Introduction to Environmental Engineering and Science	Gilbert M. Masters, Wendell P. Ela	Pearson	3rd Edition, 2007
4	Fundamentals of Heat and Mass Transfer	C.P. Kothandaraman, S. Subramanyan	New Age International	10th Revised Edition, 2020

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Engineering Thermodynamics Prof. S.K. Som, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ Thermodynamics Prof. S.P. Sukhatme, IIT Bombay https://nptel.ac.in/courses/103/101/103101004/
2	Engineering Thermodynamics Prof. S.K. Som, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ Thermodynamics Prof. C. Balaji, IIT Madras https://nptel.ac.in/courses/112/106/112106133/
3	Engineering Thermodynamics Prof. S.K. Som, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ Thermodynamics Prof. C. Balaji, IIT Madras https://nptel.ac.in/courses/112/106/112106133/ 3. Thermodynamics for Engineers Prof. Prasanta Kumar Das, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/
4	Engineering Thermodynamics Prof. S.K. Som, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ Thermodynamics Prof. C. Balaji, IIT Madras https://nptel.ac.in/courses/112/106/112106133/ Thermodynamics for Engineers Prof. Prasanta Kumar Das, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ Advanced Thermodynamics Prof. R. K. Rajput, IIT Delhi https://nptel.ac.in/courses/112/102/112102104/

SEMESTER: S4

INDUSTRIAL MANUFACTURING PROCESS

Course Code	PBAUT404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. Understand the basic concept of foundry and casting, metal forming and welding.
2. Understand different defects formed in the manufacturing process.
3. Select the proper manufacturing process for the given applications.
4. Understand the basics of advanced manufacturing technology.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Casting: Steps involved in making a casting – Advantage and applications. Patterns and pattern making, allowances in patterns – Types – Materials used for patterns, core and core making, casting design considerations. Casting processes. Methods of melting - Crucible melting and cupola operation, defects in casting.(Project Suggestion - <i>Task Projects:</i> Create a pattern for the casting)	9
2	Welding: Classification, principles of oxy-acetylene gas welding. Metal - arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding. Thermit welding, electron beam welding, laser beam welding, friction welding. Defects.(Project Suggestions – <i>Discipline Projects:</i> Make metal joining using any one of the above joining process, welding parameters, friction stir welding)	9

3	Sheet metal operations: Bending and forming, rolling, theory of rolling, types of rolling mills. Drawing and its types– wire drawing, tube drawing and deep drawing – coining – hot and cold spinning. Basic extrusion processes and its characteristics. Forging processes - Principles of forging, tools and dies - Types of forging – Open, closed, drop forging, roll forging.(Project Suggestions - <i>Problem Projects:</i> Deep drawing, forging, sheet metal works)	7
4	Non-traditional machining processes: Laser beam machining, plasma arc machining, electro chemical machining, ultrasonic machining, abrasive jet machining, water jet machining, electron beam machining, electric discharge machining. Material addition process:3D printing- stereo-lithography, selective laser sintering, fused deposition modelling, laminated object manufacturing, laser engineered net-shaping, LIGA process.(Project Suggestions - <i>Service – Learning Projects:</i> 3D printing (based on process)	11

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 =16marks)	• Each question carries 6 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 sub divisions. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concept of foundry and casting, metal forming and welding	K2
CO2	Understand different defects formed in the manufacturing process.	K2
CO3	Explain the proper manufacturing process for the given applications.	K2
CO4	Understand the basics of advanced manufacturing technology	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	-	-	-	-	-	-	2	-	-
CO3	2	2	-	-	-	1	-	-	-	-	-	-
CO4	2	2	-	-	-	-	2	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Engineering and Technology	Serope Kalpakjian, Steven R. Schmid	Pearson	8 th Edition, 2020
2	Introduction to Manufacturing Processes	John A. Schey	Tata McGraw Hill, Noida,	3 rd Edition, 1999
3	Elements of Workshop Technology Vol:1	S.K Hajra Choudhury, A.K Hajra Choudhury, Nirjhar Roy	Media Promoters & Publishers Pvt. Ltd.	8 th Edition, 1986

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Metal Casting	Carl R. Loper, Philip C. Rosenthal, and Richard W. Heine	Tata McGraw Hill Publishing Co, Ltd; New Delhi,	2 nd Edition, 1976
2	Foundry Engineering	T.R.Banga, T.Manghnani	Khanna Publishers, New Delhi,	4 th Edition, 1987
3	Manufacturing Technology (materials, processes and equipment)	Helmi A Youssef, Hassan A El-Hofy and Mahmoud H Ahmed,	CRC Press,	1 st Edition, 2011

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Course link: https://archive.nptel.ac.in/courses/112/107/112107219/ Video link: https://www.youtube.com/watch?v=rL3dLQYEEKw&t=5s
2	Course link: https://archive.nptel.ac.in/courses/112/107/112107219/ Video link: https://www.youtube.com/watch?v=KvSY8XC9C6I
3	Course link: https://archive.nptel.ac.in/courses/112/107/112107219/ Video link: https://www.youtube.com/watch?v=Xf08dgnlwXg
4	Course link: https://archive.nptel.ac.in/courses/112/107/112107078/ Video link: https://www.youtube.com/watch?v=oI3RIAvyVxc

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation / Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

Project Assessment and Evaluation criteria (30 Marks)

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S4

ALTERNATE ENERGY SOURCES FOR AUTOMOBILE

Course Code	PEAUT411	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To familiarize the students with various alternative energy sources
2. To familiarize with energy conversion, utilization and storage for renewable technologies.
3. To understand the potential of using renewable energy technologies
4. To understand the environmental aspects of energy usage and conversion

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Energy Sources: Conventional (fossil fuels, nuclear) and alternative (renewable sources like solar, wind, geothermal). Need for alternative sources: resource depletion and environmental impact. Non-conventional energy sources: solar, wind and geothermal. Classification of alternative fuels and drive trains: biofuels, hydrogen, electric, hybrid. Scenario of conventional auto fuels & oil reserves: declining availability of conventional oil reserves and its impact on fuel prices.	9
2	Biofuels for SI and CI Engines: Application in spark ignition (SI) and compression ignition (CI) engines. Alcohols for SI engines: use of methanol and ethanol as SI engine fuels. Manufacturing processes and comparison of properties with gasoline. Engine performance with alcohols: impact on engine performance and emissions. Alcohol-gasoline blends: gasohol and E85, advantages and limitations. Compressed natural gas (CNG), liquefied natural gas (LNG) and biogas: availability, properties and engine modifications. Biogas: production and application (single or dual fuel). Vegetable oils as diesel fuels: straight vegetable oil, biodiesel properties and performance in engines.	9

3	Hydrogen energy: Properties such as auto ignition temperature, boiling temperature, cetane number, flammable limits, flash point, calorific value (heating value), latent heat of vaporization, octane number, stoichiometric air- fuel ratio, pour point, cloud point, volatility, sulphur, density of hydrogen. Sources and Production of Hydrogen: electrolysis of water, thermal decomposition and biological processes. Hydrogen storage and applications: challenges and methods for storing hydrogen fuel. Applications of hydrogen and engine modifications. Hazards and safety systems: safety concerns, safety systems required. Performance and emissions, performance characteristics of hydrogen engines and emissions. Fuel cells: working principle, advantages and limitations.	9
4	Energy for Electric Vehicles: Methods for collecting and storing solar energy, working principle of photovoltaic conversion and electric vehicle applications. Wind energy for electric vehicles: introduction to wind turbines, types of wind turbines. Electric vehicles - design considerations, limitations and opportunities for improvement in electric vehicle technology. Electric motors, different types. Batteries-explore various battery types, capacities, limitations and future possibilities. Electric vehicle layout & hybrid vehicles: advantages, limitations and types of hybrid vehicles.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Acquires theoretical knowledge of conventional and non-conventional energy sources and fuel ratings	K2
CO2	Acquires the knowledge regarding use of biofuels in SI and CI engines	K2
CO3	Acquires the knowledge of properties of hydrogen and construction of fuel cells	K2
CO4	Acquires the knowledge of design considerations of electric vehicles.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1							
CO2	3	3	2	1	1							
CO3	3	3	3	2	2							
CO4	3	3	3	3	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Alternative fuels	Jack Erjavec	Cengage publications	
2	IC engines	Mathur & Sharma	Dhanpat Rai publications	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive fuels system,	T. K. Garrett	SAE INC, Warrendale,	1991
2	Automotive Fuels reference book	Keith Owen & Trevor Colley	SAE	
3	Alternate liquid fuels	Energy research group	Willey Eastern Ltd	
4	Solar energy utilization	G.D Rai	Khanna Publishers,	2004
5	Alternate fuels guide book	Richard L. Bechtold	SAE	
6	Wind Energy Explained: Theory, Design and Application	James F. Manwell, Jon G. McGowan, Anthony L. Rogers	Wiley	
7	Wind Energy: Theory And Practice	Siraj Ahmed	PHI Publications	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Course: https://nptel.ac.in/courses/103103206
2	Course: https://nptel.ac.in/courses/103103206
3	Course: https://archive.nptel.ac.in/courses/121/106/121106014/ Video: https://www.youtube.com/watch?v=r7pLUjUXbn0
4	Course: https://archive.nptel.ac.in/courses/121/106/121106014/ Video: https://www.youtube.com/watch?v=ybZbwKIB1lc

SEMESTER S4
MARKETING MANAGEMENT

Course Code	PEAUT412	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To help students understand the automotive industry, its trends, challenges, and major players.
2. Students will learn fundamental marketing concepts and strategies tailored to the automotive sector.
3. By the end of the course, students will develop practical skills in automotive marketing management, including product lifecycle management, branding, and sales strategies

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Automotive marketing : Overview of automotive industry- understanding the structure, evolution and major players in the automotive industry. Market trends and challenges - analysing current trends, challenges and opportunities shaping the automotive market. Fundamentals of marketing - Introduction to marketing concepts and principles with a focus on their application in the automotive sector. Consumer behaviour in the automotive sector - understanding consumer preferences, decision making processes and buying behaviour specific to the automotive market. Market segmentation and targeting - techniques for segmenting automotive markets based on demographic, psychographic and behavioural factors, strategies for targeting specific customer segments.	9

2	Automotive product management: Product lifecycle management - understanding the stages of the automotive product lifecycle and strategies for managing products at each stage. New product development - techniques and processes for developing new automotive products, including market research, concept development and product testing. Brand management - importance of branding in the automotive industry, brand positioning strategies and building brand equity. Product positioning and differentiation - strategies for positioning automotive products in the market and creating points of differentiation from competitors. Quality management in automotive sector - ensuring quality standards in automotive products and services and their impact on marketing strategies.	9
3	Automotive marketing communications: Integrated marketing communications - overview of marketing communication tools and channels used in the automotive industry, including advertising, public relations, sales promotion and digital marketing. Advertising and media planning - planning and executing advertising campaigns for automotive products, including media selection, message development and campaign evaluation. Digital marketing strategies - leveraging digital channels such as social media, search engine marketing and content marketing to reach and engage automotive consumers. Customer relationship Management (CRM): Importance of CRM in automotive marketing, strategies for building and maintaining customer relationships, and leveraging customer data for personalized marketing. Brand Activation and Sponsorship: Implementing brand activation strategies and leveraging sponsorship opportunities to enhance brand visibility and consumer engagement.	9
4	Automotive Retailing: Overview of automotive retailing channels, including dealerships, online sales platforms and direct-to-consumer models. Sales Management: Techniques for managing automotive sales teams, setting sales targets and developing sales strategies. Channel Management: Strategies for managing distribution channels in the automotive industry, including dealer networks, franchise agreements and channel conflict resolution. After-Sales Service and Support: Importance of after-sales service in automotive marketing, strategies for enhancing customer satisfaction and loyalty through service and support initiatives.	9

	Legal and Ethical Issues in automotive marketing: Understanding legal and ethical considerations in automotive marketing practices, including advertising regulations, consumer protection laws, and environmental responsibilities.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Students will demonstrate knowledge of the structure, evolution, and major players in the automotive industry, as well as current trends and challenges.	K1
CO2	Students will exhibit an understanding of fundamental marketing concepts and principles and their application in the context of the automotive sector	K2
CO3	Students will understand consumer behaviour specific to the automotive market, including preferences, decision-making processes, and buying behavior	K1
CO4	Students will comprehend various marketing communication tools and channels used in the automotive industry, including advertising, digital marketing, and customer relationship management	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	2	-	-	-	-	-	-	-	-	-
CO4	-	-	-	2	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Marketing Management: Analysis, Planning, Implementation and Control	<u>Philip T. Kotler</u>	-	-
2	Essentials of Management	Harold Koontz , Heinz Weihrich, Mark V. Cannice	Mc Graw Hill	2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Marketing innovations in the Automotive industry	Elena Candelo	Springer	-
2	Automotive Product Development	Vivek D Bhise	CRC Press	-
3	Mastering Automotive Digital Marketing	Brian F Pasch	-	-

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/110104068
2	https://onlinecourses.swayam2.ac.in/imb23_mg60/preview
3	https://archive.nptel.ac.in/courses/110/104/110104070/
4	https://onlinecourses.nptel.ac.in/noc22_mg57/preview

SEMESTER S4
INDUSTRIAL SAFETY ENGINEERING

(Branch- AU/Group- C)

Course Code	PEAUT415	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart knowledge of various safety management principles and various safety systems
2. To compare different hazard identification tools and choose the most appropriate based on the nature of industry

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Need for safety: Safety and productivity. Definitions - Accident, injury, unsafe act, unsafe condition, dangerous occurrence, reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety officer-responsibilities, authority. Safety committee-need, types and advantages	9
2	Personal protection in the work environment: Types of PPEs, personal protective equipment, respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring safety performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping - responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system - objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.	9

3	Safety hazards in machines: Machinery's safeguard - Point of operation, Principle of machine guarding - types of guards and devices. Safety in turning, and grinding. Welding and cutting - safety precautions of gas welding and arc welding. Material handling - classification - safety consideration - manual and mechanical handling. Handling assessments and techniques - lifting, carrying, pulling, pushing, palletizing and stocking. Material handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains, slings, hooks, clamps. Hearing conservation program in production industries.	9
4	Hazard identification and analysis: Hazard and risk, types of hazards – classification of fire, types of fire extinguishers, fire explosion and toxic gas release, structure of hazard identification and risk assessment. Identification of hazards - inventory analysis, fire and explosion hazard rating of process plants, - Dow fire and explosion hazard index, preliminary hazard analysis, hazard and operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of chemical hazards, hazardous properties of chemicals, material safety data sheets (MSDS).	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts of workplace safety, including definitions, theories of accident causation, and the roles of various stakeholders, promoting a safer work environment	K2
CO2	Demonstrate competency in selecting, utilizing, and maintaining personal protective equipment (PPE), and implementing safety protocols like housekeeping and work permit systems to enhance workplace safety	K2
CO3	Identify and mitigate safety hazards associated with machinery operations, including machine safeguarding, welding practices, material handling techniques, and maintenance of equipment, ensuring a safer industrial environment	K2
CO4	Demonstrate proficiency in identifying, assessing, and managing hazards and risks associated with chemical processes and fire safety, utilizing methodologies like HAZOP and Dow Fire and Explosion Hazard Index to ensure workplace safety.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							
CO2	3	2	3	3	2							
CO3	3	3	3	2	3							
CO4	3	3	3	3	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Safety, Health and Environment management systems	R.K Jain	Khanna Publications	2000
2	Safety and Health for Engineers	Roger L. Brauer	Wiley	2016
3	Safety management system	Waring, Alan	Chapman & Hall, England	1996

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Safety management in Industry	Krishnan, N.V.	Jaico Publishing House, New Delhi.	1997
2	Industrial safety	Ronald P. Blake	Prentice Hall, New Delhi.	1992

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Prof. J. Uma Maheswari, IIT Delhi, https://youtu.be/WxyfKNQkj8g
2	Industrial Safety Engineering, By Prof. Jhareswar Maiti IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_mg43/preview https://youtu.be/jFDWIKayrTc
3	Prof .shishir https://youtu.be/Bq4hVTJpvKk
4	Industrial Safety And Fire Safety Management , By Dr. P.K.Ghosh & Mrs.Annapurna Adiley Chhattisgarh Swami Vivekanand Technical University (CSVTU), Bhilai , https://onlinecourses.swayam2.ac.in/nou23_ge81/previe

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with an understanding of fundamental economic principles essential for effective decision-making in engineering contexts.
2. To enable students to apply economic analysis to production decisions, cost management, and market strategies in engineering practice.
3. To equip students with the ability to evaluate macroeconomic scenarios, financial methods, and investment decisions relevant to engineering projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility –Demand: Factors determining demand – Law of Demand – Demand curve- Price elasticity of demand- measurement of price elasticity and its applications – Supply: factors determining supply - Law of supply – Supply curve- Equilibrium price determination- Changes in demand and supply and its effects on equilibrium price and quantity Production: Production function - Law of variable proportion –Returns to scale- Cobb-Douglas Production Function	6
2	Cost: Cost concepts – Private cost and social cost – Sunk cost – Opportunity cost -Explicit and implicit cost –Short run cost curves –Long run average cost curve -Revenue concepts – Break-even point Market: Perfect Competition – Monopoly - Monopolistic Competition (features and equilibrium of a firm) - Oligopoly – Features – Kinked demand model	6

3	National income: Concepts (GDP, GNP and NNP)– Final goods and Intermediate goods - Methods of Estimation –output method – expenditure method-- Difficulties in the measurement of national income. Inflation: Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Repo and reverse repo rate	6
4	Value Analysis and value Engineering: Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure Capital Budgeting: Time value of money - Net Present Value Method - Benefit Cost Ratio – Internal Rate of Return – Payback – Accounting Rate of Return.	6

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems and national income.	K2
CO4	Make use of the possibilities of value analysis and engineering, and take investment decisions through capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012
4	Financial Management	I M Pandey	Vikas Publishing House	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001
5	Financial Management: Theory and Practice	Prasanna Chandra	Mc Graw Hill	2007

MODEL QUESTION PAPER				
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY				
THIRD SEMESTER B. TECH DEGREE EXAMINATION, MONTH AND YEAR				
Course Code: UCHUT346				
Course Name: Economics for Engineers				
Max. Marks: 50			Duration: 2 hours 30 minutes	
	PART A			
		Answer all questions. Each question carries 3 marks	CO	Marks
1		What are the central problems of an economy?	CO1	(3)
2		Point out any three applications of price elasticity of demand.	CO1	(3)
3		What is the social cost of production?	CO2	(3)
4		What is repo rate?	CO3	(3)
5		What is esteem value?	CO4	(3)
6		Write a short note on time value of money.	CO4	(3)
PART B				
Answer any one full question from each module. Each question carries 8 marks				
Module 1				
9	a)	Suppose a country is producing at a point inside the production possibility curve. Draw a PPC and examine this situation.	CO1	(5)
	b)	State the law of demand. Point out any two exceptions of this law.	CO1	(3)
10	a)	A consumer purchases 10 units of a commodity when its price is Rs.100. Later when its price falls to Rs.90, he purchases 8 units only. Estimate price elasticity. What type of a commodity is this?	CO1	(5)
	b)	State the law of variable proportion.	CO1	(3)

Module 2				
11	a)	What is oligopoly? Why price is rigid under oligopoly?	CO2	(5)
	b)	The cost function of a firm is given as $TC=1000+10Q-6Q^2+Q^3$. Calculate fixed cost, variable cost and marginal cost when output is 10 units.	CO2	(3)
12	a)	Suppose a firm is earning super normal profit under monopolistic market condition. Explain this situation by drawing a diagram.	CO2	(5)
	b)	Suppose a firm sells its product at a price of Rs.10 per unit and its average variable cost is Rs.6. If the firm spend Ra.10000 as rent and pay Rs. 6000 as interest every month, estimate its break-even level of output.	CO2	(3)
Module 3				
13	a)	What is inflation? How does inflation affect investment and production.	CO3	(5)
	b)	How will you obtain NNP _{fc} from GDP _{mp} .	CO3	(3)
14	a)	From the data given below (In Rs. Crores) estimate GDP _{mp} and national income. Private final consumption expenditure = 1000, Government expenditure = 500, Invest expenditure = 700, Net exports = 300, Depreciation = 200, NFIA=(-200) and Net indirect tax = 100	CO3	(5)
	b)	What is bank rate? Examine the bank rate policy of the government during inflation.	CO3	(3)
Module 4				
15	a)	Examine the procedures of value engineering.	CO4	(5)
	b)	Examine the application areas of value engineering	CO4	(3)

16	a)	1. Suppose the initial investment of a project is Rs. 3000 (Crores) and the cost of capital or the opportunity cost of capital is 10 percent. Calculate NPV of the project based on the cash flows given below. Year 1 2 3 4 5 Cash flow 1000 900 800 700 600 (In Crores)	CO4	(5)
	b)	Point out any three merits of NPV method.	CO4	(3)

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism , Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution -Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places -accessibility and social impacts, Managing conflict , Collective bargaining, Confidentiality , Role of confidentiality in moral integrity, Codes of Ethics . Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education , employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in connection with gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives .	6
2	Introduction to Environmental Ethics : Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles : Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity : Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on	6

	ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	
3	Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	6

Course Assessment Method (CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks				50

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:**Module-II**

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college

campus etc) and propose conservation strategies to protect it.

- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER: S4

PRODUCTION ENGINEERING LAB

Course Code	PCAUL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To develop students' practical skills in using various machine tools and techniques, including lathe, milling, shaper, and grinding machines, for performing fundamental machining operations such as cutting, threading, and finishing.
2. To enable students to understand and apply principles of tool grinding, tool wear analysis, and the use of jigs and fixtures, thereby enhancing their ability to optimize machining processes and tool life.
3. To equip students with the knowledge and hands-on experience in advanced manufacturing technologies, such as CNC programming and machining, 3D printing, and various welding methods, preparing them for modern production environments.

Expt. No.	Experiments
1	Force Analysis using Lathe tool dynamometer
2	Thread making on Lathe machine
3	Tool grinding (to provide tool angles) on tool-grinder machine.
4	Spur gear cutting on Milling machine
5	Machining a block on shaper machine
6	Finishing of a surface on surface-grinding machine
7	Drilling holes on drilling machine.
8	Study of different types of tools and its angles & materials
9	Experiment on tool wear and tool life.
10	Experiment on jigs/Fixtures and its uses
11	Gas welding experiment
12	Arc welding experiment
13	Resistance welding experiment.
14	Soldering & Brazing experiment
15	CNC Programming Simulation using any software
16	CNC machining in CNC Lathe

17	CNC Milling in a VMC
18	Metal Cutting Experiments (Example: Cutting Force Measurement, Cutting Temperature Measurement etc.)
19	3D Printing

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and recall the functions and operations of various machine tools such as lathes ,milling machines, shaper machines and surface grinders.	K1
CO2	Remember the different types of welding processes, including gas welding, and resistance welding, along with their applications.	K1
CO3	Understanding the principles of tool grinding, including the importance of tool angles and materials , how they affect machining performance	K2
CO4	Comprehend the processes involved in CNC programming and machining, and the benefits of CNC technology in modern manufacturing.	K2
CO5	Apply practical techniques to perform various machining and welding operations such as gear cutting ,thread making, and 3D printing, using appropriate tools and equipment.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	2	-	-	-	-	-	-	-

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Production Technology	R. K. Jain	Khanna Publishers	Jan 2022
2	A Course in Workshop Technology	B. S.Raghuwamshi	DhanpatRai & Sons	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Engineering and Technology	Kalpakjin S	Pearson Education	2018
2	Production Technology	HMT	McGraw-Hill Education	2001

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Production Technology: Theory And Practice , By Prof. Sounak Kumar Choudhury IIT Kanpur https://onlinecourses.nptel.ac.in/noc22_me99/preview

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER: S4

THERMAL ENGINEERING LAB

Course Code	PCAUL408	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To enable students to conduct experiments and determine key properties of fuels and oils, including flash and fire points, viscosity, and calorific values, using standard laboratory techniques and equipment.
2. To familiarize students with the operational principles and performance characteristics of internal combustion engines, including petrol, diesel, and turbocharged engines, through hands-on experimentation and analysis.
3. To equip students with the knowledge and skills to perform advanced tests on internal combustion engines, such as heat balance tests, volumetric efficiency determinations, and economic speed tests, to evaluate engine performance and efficiency under various operating conditions.

Expt. No.	Experiments
1	Determination of flash and fire points of petroleum fuels and oils
2	Determination of viscosity of lubricating oils and fuels and its variation with temperature
3	Determination of calorific value of solid and liquid fuels- Bomb Calorimeter/Junkers Gas Calorimeter
4	Determination of calorific value of gaseous fuels –Gas Calorimeter
5	Familiarisation of various systems and subsystems of petrol engine / MPFI engine
6	Familiarisation of various systems and parts of Diesel engine / Turbocharged engine
7	Performance test on petrol engines / MPFI engine
8	Performance test on Diesel engines / Turbocharged engine
9	Heat Balance test on petrol/Diesel engines
10	Determination volumetric efficiency, isothermal efficiency and Air-fuel ratio of IC engines
11	Cooling curve of IC engines
12	Valve timing diagram of IC engines
13	Economic speed test on IC engines

14	Retardation test on IC engines
15	Morse test on petrol engine
16	Experiment to find flame temperature of premixed flames at different equivalence ratios and temperature of diffusion flames at different fuel flow rates
17	Analysis of automobile exhaust gas and flue gas using exhaust gas analyser / Orsat apparatus
18	Performance test on reciprocating compressor
19	Performance test on rotary compressor/blower
20	Performance Test on Two stroke engine

**Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Recall and identify the properties of fuels and oils, including flash points, viscosity, and calorific values, through experimental data collection and analysis	K1
CO2	Remember and recognize the operational principles and performance parameters of different types of internal combustion engines, including petrol, diesel, and turbocharged engines	K1
CO3	Understand the significance of experimental methods for determining fuel properties and engine performance characteristics, and their relevance to real-world applications in thermal engineering	K2
CO4	Comprehend the principles behind various engine performance tests, such as heat balance tests, volumetric efficiency determinations, and economic speed tests, and their implications on engine design and operation	K2
CO5	Apply their knowledge and skills to conduct experiments, analyze data, and interpret results related to fuel properties, engine performance, and exhaust gas analysis, fostering practical problem-solving abilities in thermal engineering	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3											
CO3	1		2									
CO4	1		3		1							
CO5	1				3							

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of IC engines	V. Ganesan	Tata McGraw-Hill	2017
2	A text book of internal combustion engines	R K Rajput	Laxmi Publications	2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	I.C engine fundamentals	J.B.Heywood	McGraw-Hill	2017
2	An Introduction to Combustion: Concepts and Applications	Stephen R Turns	McGraw-Hill	2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Thermal Engineering: Basic and Applied By Prof. Pranab K. Mondal IIT Guwahati https://onlinecourses.nptel.ac.in/noc23_me31/preview

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 5
AUTOMOBILE ENGINEERING

SEMESTER S5

AUTOMOBILE ELECTRICAL AND ELECTRONICS

Course Code	PCAUT501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic Electrical & Electronics Engineering (GCEST204)	Course Type	Theory

Course Objectives:

1. Understand automotive battery technologies, charging, and starting systems.
2. Learn about ignition systems, fuel injection types, and their applications.
3. Explore automotive lighting, instrumentation, wiring systems, diagnostics, sensors, actuators, and IOT integration

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Principle of lead acid battery & constructional details, Effect of temperature on electrolyte, Capacity Rating, Battery charging methods, Battery tests. Developments in storage: Nickel metal hydride battery, Lithium-ion battery, Fuel cells, Ultra capacitors. Charging system: Working and constructional details of Alternators (single and three phase), Rectification, voltage regulation, current regulation, Charging circuit for 3 phase alternators. Starting system: Requirement of starter motor; Starter Motor types, construction and characteristics, Starter drive mechanisms, Starting circuit, Starter Switches.	11
2	Centrifugal and Vacuum advance mechanisms, Spark plugs, constructional details and types. Electronic fuel injection system overview; D jetronic, K jetronic and L jetronic fuel injection; Injections schemes Single point, Multi point, Sequential, Direct injection, Common rail direct injection, Gasoline direct injection, Supercritical injection.	11

3	Lighting: Types of headlights, headlight reflectors, headlight lenses, indicator lamp details, lighting circuit, projector headlights; Horn and wiper mechanisms. Instrumentation: Speedometer, Fuel Level Indicator, Oil Pressure and Coolant Temperature Indicators, Display devices LED, LCD, VFD, Automotive Wiring System – CAN – LIN - FLEXRAY- MOST- Connected cars- Introduction -Smart cars and traffic systems - On-board diagnostics (OBD), OBD II.	11
4	Sensors and applications in Automobile: Pressure sensors, Temperature sensors, Position sensors, Lambda sensor, Air flow sensor, Wheel speed sensor, Knock sensor, Optical sensors. Actuators: Solenoids, Stepper motors, Relays, Piezoelectric. Introduction to internet of things (IOT) and its automotive applications. Basics principles of ECU - Architecture and Components of Generic ECU - Design and types of ECU	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles and operational details of lead-acid batteries, battery charging methods, and starter motor technologies in automotive applications	K2
CO2	Understand the working principles of electronic fuel injection systems and the different injection schemes used in modern vehicles. .	K2
CO3	Understand the functionalities of automotive lighting systems, instrumentation components like speedometers and indicators, and the basics of automotive wiring systems.	K2
CO4	Understand the applications and operational principles of various sensors and actuators used in automotive systems, including their integration with electronic control units (ECUs).	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								
CO2		3	3	3	2							
CO3			3	3	3							
CO4			3									
CO5												

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Electrical Equipment	Kohli.P.L.	Tata McGraw-Hill Co Ltd	2017
2	Automobile Electrical and Electronics system	Tom Denton	Elsevier Butterworth-Heinemann	2004

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Electricity and Electronics	Al Santini	Cengage Learning	2012
2	Automotive Handbook	Robert Bosch	Bently Publishers	2011
3	Understanding automotive electronics	William B. Ribbens, Norman P. Mansour	Newnes	1992
4	Automotive Electrical HandBook	Jim Horner	Penguin	1987

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	1. Electrochemical Energy Storage, Prof. Subhasish Basu Majumder IIT Kharagpur, https://nptel.ac.in/courses/113105102

SEMESTER S5

THEORY OF MACHINES

Course Code	PCAUT502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GCEST103, PCAUT403	Course Type	Theory

Course Objectives:

1. Understand about kinematic pairs, chains, and degrees of freedom, and analyze 4-bar and slider crank chains for velocity and acceleration.
2. Explore the types and functions of governors, cams, and followers, and analyze their motion characteristics and cam profile generation.
3. Gain insights into gears, gear trains, flywheels, and the balancing of rotating and reciprocating masses, including the principles of gyroscopic effects in vehicle stability.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Planar Mechanisms: Terminology and definitions. Kinematic pairs, kinematic chains, and degrees of freedom of mechanisms. Kinematic Inversion of 4-bar and slider-crank chains. Velocity Analysis: Relative motion -relative velocity. Acceleration Analysis- Relative acceleration – Concept of Coriolis acceleration (No numericals & derivation)	11
2	Governors: Terminology and classification; Watt, Porter, Proell, Hartnell, Hartung, quality of governors, inertia governors- governor speed control Cams and Followers: Classification of cams and followers. Displacement diagrams. Velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, and cycloidal motion, Cam profiles with and without offset.	11
3	Gears and Gear Trains: Classification of gears. Terminology and definitions of spur gears. Law of gearing, length of path of contact, arc	11

	of contact, and contact ratio. Interference and minimum number of teeth to avoid interference. Simple and compound gear trains. Planetary gear trains, differential, Gear ratio of planetary gear trains. Flywheels: Turning moment diagrams. Fluctuation of energy. Flywheel, size of flywheel (No numerical problems).	
4	Balancing of Rotating Masses: Static and dynamic balancing. Balancing of masses rotating in several planes. Balancing of Reciprocating Masses: Balancing of reciprocating masses. Gyroscope: Principle-Angular Acceleration-Effect of gyroscopic couple airplanes, and ships, stability of automobile and two-wheel vehicles.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles of planar mechanisms and their components, including kinematic pairs, chains, and degrees of freedom.	K2
CO2	Understand the classification and operational principles of governors, and apply velocity and acceleration analysis techniques to cams in various motion profiles.	K2
CO3	Understand the classification and terminology of gears, and analyze gear trains including planetary gears and differentials	K2
CO4	Understand the concepts and methods of balancing rotating and reciprocating masses, and evaluate the principles and applications of gyroscopes in vehicle stability	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	1	2	2								
CO3	3	2	3	1								
CO4	2	1	2		2							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory of Machines	R.S. Khurmi, J.K. Gupta	S. Chand & Company Ltd	17th Edition, 2023
2	Design of Machine Elements	V. B. Bhandari	McGraw Hill Education	4th Revised Edition, 2019
3	Theory of Machines	S.S. Rattan	McGraw Hill Education	4th Edition, 2017
4	Kinematics and Dynamics of Machinery	Charles E. Wilson, J. Peter Sadler	Pearson Education	3rd Edition, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanism Design: Analysis and Synthesis	Arthur G. Erdman, George N. Sandor	Pearson Education	4th Edition, 2017
2	Design of Machine Elements	V. B. Bhandari	McGraw Hill Education	4th Revised Edition, 2019
3	Automobile Engineering	Kripal Singh	Standard Publishers	8th Edition, 2018

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
	Course Title: Kinematics of Mechanisms and Machines (https://onlinecourses.nptel.ac.in/noc20_me21/preview)

SEMESTER S5

AUTOMOTIVE TRANSMISSION

Course Code	PCAUT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart basic knowledge in automotive transmission.
2. To understand the construction and principle of operation of various types of mechanical transmission components, hydrodynamic devices, hydrostatic devices and automatic transmission system

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Clutch And Gear Box Requirement of transmission system, Principle of operation of clutches, classification, Construction of Single plate coil spring and Diaphragm spring clutches, Multi plate clutch, Cone clutch, Semi centrifugal clutch , Centrifugal clutch. Need and Objectives of Gear box. Construction and operation of Sliding mesh, Constant mesh and Synchromesh gearboxes, CVT and DCT – Simple problems on determination of gear ratios for vehicles.	9
2	Epicyclic Gearboxes and Application Principle of Planetary gear trains – Ford – T-model gearbox, Wilson Gear box, Electromagnetic transmission, Chevrolet “Turboglide” Transmission, Hydraulic control system for Automatic Transmission.	9
3	Hydrodynamic Transmission Fluid coupling-Principle-Constructional details. Performance characteristics. Reduction of drag torque in fluid coupling. Torque converter-Principle-	9

	constructional details, performance characteristics. Multistage torque converters and Polyphase torque converters.	
4	Hydrostatic And Electric Drives Hydrostatic drive; Various types of hydrostatic systems – Principles of Hydrostatic drive system. Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, construction and working of typical Janny hydrostatic drive. Electric drive-types- Principle of early and modified Ward Leonard Control system-Advantages & limitations.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the Construction and working of different types of clutches, and gear boxes.	K2
CO2	Understand the Construction and working of different types of epicyclic gearboxes	K2
CO3	Compare the constructional details and principle of operation of hydrodynamic drives and hydraulic control.	K1
CO4	Compare various types of Hydrostatic drives, explain the principle of operation, advantages and limitations of electric drive	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2							
CO2	3	2	2	-	2							
CO3	3	3	2	-	2							
CO4	3	3	2	-	2							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Motor Vehicle	Newton K and Steeds. W.	Butter Worth's & Co., Publishers Ltd	2001
2	The Automotive Transmission Book	Fischer and Pollack	Springer	2014
3	Automobile Mechanics	N. K. Giri	Khanna publishers	2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Transmission and Power Trains construction	Crouse W.H., Anglin D.L.	McGraw Hill	1992
2	Torque converters	Heldt, P.M.	Chilton Book Co.	1992
3	Modern Transmission systems	Judge, A.W.,	Chapman and Hall Ltd.	1990

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Design of Mechanical Transmission Systems, IIT Madras, Prof. Ramkumar P https://onlinecourses.nptel.ac.in/noc24_me71/preview
	Fundamentals of Automotive Systems, IIT Madras, Prof. C. S. Shankar Ram

SEMESTER S5

COMPUTER AIDED DESIGN AND MANUFACTURING

Course Code	PBAUT504	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand and compare CAD technologies with traditional methods of designing, focusing on advantages such as efficiency, precision, and cost-effectiveness
2. Explore different topologies of CAD systems, including design databases, graphic standards, and data exchange formats, and understand their role in facilitating efficient design processes
3. Acquire practical skills in 2D graphics algorithms, transformations and grasp fundamental concepts in 3D graphic

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Evolution of CAD/CAM and CIM, Industrial Look at CAD, Comparison of CAD with traditional designing, Application of Computers in Design. Topologies of CAD systems- Design database, graphic Standards, data Exchange Formats, virtual Reality. 2D graphics: Line drawing algorithms, DDA line algorithm – Circle drawing, Bresenham's circle drawing algorithm- 2D transformation: translation, rotation, scaling, reflection, clipping – 3D graphics basics Shigley Modelling in CAD <i>Suggestion:-Task project- Students can choose their focus areas such as Virtual Machine Simulation, Design and Development of a Virtual Reality (VR) ,Simulation for Mechanical Assembly</i>	9

2	NC part programming: part programming Fundamentals- manual programming – NC Coordinate systems and axes– sequence number, preparatory Functions Computer aided part programming: Concept and need of CAP – CNC languages – APT language structure: Geometry Commands, Motion Commands, Post processor Commands, Compilation Control Commands- Programming exercise <i>Suggestion: -Task project- Students can choose their focus areas such as – NC Coordinate systems, C NC Coordinate systems</i>	9
3	Introduction to part families- parts classification and coding – group technology machine cells- benefits of group technology – Process Planning – CAPP & types of CAPP- Automated process planning- AI in process planning, Process planning software's Flexible Manufacturing systems: Introduction, Types, concepts, need and advantages of FMS, Cellular and FMS- , applied to FMS <i>Suggestion:-Task project- Students can choose their focus areas such as – Flexible Manufacturing systems, AI in process planning</i>	9
4	CIM wheel – CIM Database- CIM-OSI Model– Networking Standards in CIM Environment –Network structure – Network architecture –TCP/IP, MAP – Virtual Reality, Augmented Reality-Artificial Intelligence and Expert system in CIM. Introduction to Rapid prototyping Robot technology: Basic Components- Sensors and Actuators- Robot application in Automotive Industry <i>Suggestion: -Task project- Students can choose their focus areas such as – CIM, OSI, JIT and GT, Virtual Reality</i>	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 = 16 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Gain proficiency CAD technologies, including their evolution, industrial applications, comparison with traditional design methods, and practical application of computer-aided design principles	K3
CO2	Demonstrate the ability to develop and interpret manual and computer-aided NC part programs, effectively utilizing NC coordinate systems, preparatory functions, and APT language commands for precise manufacturing operations.	K3
CO3	Understand group technology principles, and develop efficient process plans, including the utilization of AI and flexible manufacturing systems for enhanced production efficiency.	K2
CO4	Understand networking, AI, virtual technologies, and robotics to enhance manufacturing processes and systems, particularly in the automotive industry	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2		3	3						
CO2		2	2	3			3					
CO3		2	2	3			3					
CO4		2	2				3					

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CAD/CAM: Principles and Applications	P. N. Rao	Tata McGraw Hill Education	2019
2	Computer Aided Manufacturing	T. V. Prabhakaran	New Age International Publishers	2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Integrated Manufacturing	Amitabha Ghosh and Asok Kumar Mallik	PHI Learning Pvt. Ltd.	2020
2	Manufacturing Systems: Theory and Practice	H. K. Shivanand and S. D. Deshpande	Sanguine Technical Publishers	2018
3	Computer-Integrated Manufacturing	David D. Bedworth and James E. Henderson	Pearson	2005

Video Links (NPTEL, SWAYAM...)	
Sl No	Link ID
1	Automation in Manufacturing IIT Guwahathi ,Prof. Shrikrishna N joshi https://onlinecourses.nptel.ac.in/noc20_me58/preview

SEMESTER S5

MECHATRONICS AND CONTROL SYSTEMS

Course Code	PCAUT521	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart knowledge on mechatronic systems, data presentation, and control mechanisms using sensors, transducers, and activation systems
2. To impart knowledge on signal conditioning, input/output systems, and electromechanical devices, emphasizing practical mechatronic design and fault-finding solutions
3. To understand control systems engineering, including automatic control concepts, system representation, transfer functions, block diagrams, and practical control applications
4. To understand system response, control system analysis, frequency response, and stability criteria using techniques like Bode plots and root locus

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Mechatronics: Systems-Microprocessor based controllers - mechatronic approach - sensors - transducers - force - velocity displacement - temperature Data presentation systems: Displays - measurement systems - calibration - pneumatic and hydraulic systems - control valves - actuators - mechanical and electrical activation systems-relays and solenoid switches - proximity pickups.	9
2	Signal Conditioning: Signal conditioning - operational amplifiers - filtering – multiplexers Input/output Systems: Ports, interface requirements, adaptors - programmable logic controllers - data handling digital communications - system, networks, protocols, interfaces, fault finding - design and	9

	mechatronic design solutions. Electromechanical systems: CD, DVD Rom, OCR, Printers	
3	Introduction to Control Systems Engineering: Concept of automatic control - open loop and closed loop systems - transfer functions - Representation of control components and systems -Translational and rotational mechanical components – series and parallel combinations - Block diagrams - comparators, integrating devices, Servomechanisms, hydraulic servomotors, temperature control systems, speed control systems.	9
4	System Response: First and second order system - Response to step, pulse, ramp and sinusoidal input-systems with distance, velocity lag. Control System Analysis: Transient Response of simple control systems - Stability of control systems - Routh Stability criteria - Error Analysis. Frequency Response Analysis: Polar plots - Experimental determination of frequency response - Bode plot and Nyquist stability criteria - Gain and phase margin. Root locus of simple transfer function.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the integration of sensors, microprocessor controllers, actuators, and data presentation systems in mechatronic designs.	K2
CO2	Understand the signal conditioning techniques, input/output systems, and electromechanical components essential for designing integrated mechatronic systems and solutions.	K2
CO3	Understand the control system concepts, transfer functions, and components to comprehend the design and operation of automatic control systems effectively.	K2
CO4	Understand the system response characteristics, control system stability, and frequency response analysis using Bode plots, Nyquist criteria, and root locus method	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3							
CO2	3	3	3	2	3							
CO3	3	3	3	2	3							
CO4	3	3	3	2	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechatronics	Bolton W	Pearson Education Asia, New Delhi	2002
2	Introduction to Mechatronics and Measurement Systems	David G. Alciatore and Michael B. Hstand	McGraw-Hill Education	2011
3	Control Systems Engineering	Norman S. Nise	Willey Publication	2019
4	Modern Control Engineering	Katsuhiko Ogata	Pearson Education	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechatronics- Principles, Concepts and Applications	Nitaigour Premchand Mahalik	Tata McGraw-Hill Pub. Co. Ltd., New Delhi	2003
2	Mechatronics	HMT	Tata McGraw Hill Publishers, New Delhi	2000
3	Modern control system	Dorf, R.C., and R.H. Bishop	Pearsons Education	2016
4	Automatic Control Systems	Kuo B.C	Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition	1991

Video Links (NPTEL, SWAYAM...)	
	Link ID
1	Mechatronics by Prof. Pushparaj Mani Pathak, IIT Roorkee - https://nptel.ac.in/courses/112107298
2	Control systems by Prof. C. S. Shankar Ram, IIT Madras - https://onlinecourses.nptel.ac.in/noc24_de18/preview

SEMESTER S5

AUTOMOTIVE POLLUTION AND TESTING

Course Code	PEAUT522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. To understand pollutant sources, formation mechanisms, environmental impacts, and compliance with international emission standards.
2. To demonstrate proficiency in analyzing the formation of pollutants like NO_x, CO, particles, and hydrocarbons in engines, and applying emission measurement procedures for vehicles.
3. Apply knowledge of emission control technologies in gasoline and diesel vehicles, evaluate inspection procedures, and assess vehicle replacement and retrofit programs to meet emission standards.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Pollutants – sources – formation – effects of pollution on environment – human. Emission standards & regulations –International standards, US, European union standards, & Indian standards. Compliance with standards – certification - assembly lane testing – In use surveillance & recall.	9
2	Mechanism of pollutant formation – Formation of NO _x & CO in SI and CI engines – formation of particles in SI and CI engines – oxidation of soot – role of soot inhibitors Formation of HC – aldehydes, ketones, alcohols, and organic acids - formation of HC in SI and Diesel Engines. Non-Exhaust Emissions - Emission measurement and testing procedures – light and heavy-duty vehicles & two wheelers. Crankcase, evaporative, refuelling and on-road emissions. NDIR analysers, FID, Chemiluminescence analysers etc.	9

3	Technology for controlling emissions – Gasoline fuelled vehicles – A/F ratio, electronic control. Catalytic convertors – two way and three way convertors – catalytic wear and poisoning. Diesel fuelled vehicles – engine design – exhaust after treatment – Particulate trap EGR- Crankcase emission and control - evaporative emission and control – fuel dispensing and distribution emissions and control, SCR, diesel oxidation catalyst (DOC) Diesel Exhaust Fluid (DEF),	9
4	Controlling emission - inspection procedures for SI engines – exhaust & evaporative emissions – motorcycle white smoke. Institutional setting for inspection and maintenance – centralized and decentralized I/M – comparison – inspection frequency and roadside inspection Vehicle replacement and retrofit programs – scrap age and relocation – replacement – retrofit program.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the sources and formation of pollutants, their environmental impacts, and the significance of international and national emission standards	K2
CO2	Understand the mechanisms of NO _x , CO, HC, and particulate formation in engines, and explain the methods for measuring emissions from different types of vehicles	K2
CO3	Understand the emission control technologies for gasoline and diesel vehicles, including catalytic converters, particulate traps, and selective catalytic reduction (SCR) systems.	K2
CO4	Understand exhaust and evaporative emission inspection procedures, compare centralized and decentralized inspection systems, and analyze vehicle replacement and retrofit programs for emission reduction strategies.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2		3	2	3								
CO3			3	3								
CO4			3	2	2							
CO5												

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Pollution & Control	AK Babu	AKB Publishers	2020
2	Internal Combustion Engines	V Ganesan	McGraw Hill Education	4 th edition,
3	Automobiles and pollution	Paul Degobert	Editions Technip	1995

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Air pollution from motor vehicles	Asil Faiz, C S Weaver, M P Walsh	The World bank	1996
2	Automotive Fuel and Emissions Control Systems	James D. Halderman	Prentice Hall Multimedia Series In Automotive Technology	2005
3	Automotive emission control,	W.M. Crouse and A.L. Anglin	McGraw Hill Co., New York	1993

Video Links (NPTEL, SWAYAM...)	
Sl No	Link ID
1	Environmental Air Pollution, Prof. Mukesh Sharma , IIT Kanpur , https://nptel.ac.in/courses/105104099

SEMESTER S5

AUTOMOTIVE REFRIGERATION AND AIR CONDITIONING

Course Code	PEAUT523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the fundamental principles of refrigeration and air conditioning systems, including thermodynamics, cycle efficiency, and types of refrigerants used.
2. Understand and classify various air conditioning systems, components, and their operational principles, focusing on their layout and impact on automotive and building environments.
3. Understand and optimize air distribution systems, including duct sizing, ventilation, and control mechanisms.
4. Develop proficiency in diagnosing, servicing, and maintaining air conditioning systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Principles of refrigeration: Thermodynamics of refrigeration Carnot, reversed Carnot cycle, heat pump, and refrigerator- coefficient of performance -unit of refrigeration. Refrigeration methods-conventional refrigeration systems. Air refrigeration system –Bell Coleman cycle -C.O.P –capacity, types of refrigerants.	9
2	Air Conditioning Systems - Classification, layouts, central, unitary air conditioning systems, components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems, Automotive heaters, Types, Heater Systems, Air conditioning protection, Engine protection. Load Analysis: Outside & inside design consideration, factors forming the load on refrigeration & air conditioning systems, procedure for cooling & heating load calculation in automobiles, effect of air conditioning load on engine performance.	9

3	Air Distribution Systems: Distribution duct system, sizing, supply and return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles. Air Routing & Temperature Control: Objectives, evaporator air flow through the recirculating unit, automatic temperature control, duct system, controlling flow, vacuum reserve, testing the air control of air handling systems. Air Conditioning Control: Common control such as thermostats, humidistat, control dampers, pressure cut outs, relays	9
4	Air conditioning service: Air conditioner maintenance & service- causes of air conditioner failure, leak testing guide, discharging the system. Evacuating the system, charging the system, servicing heater system, removing & replacing components, trouble shooting of air conditioning system, compressor service, methods of dehydration, charging & testing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles and efficiency of refrigeration cycles, including Carnot and reversed Carnot cycles, and explore different refrigeration methods,	K 2
CO2	Understand the classification, components, and study operation of various air conditioning systems, analyze load factors for optimal cooling and heating in automotive and building environments, and evaluate their impact on performance and protection mechanism	K2
CO3	Learn the principles and design of air distribution systems, air routing and temperature control mechanisms, and the functioning of air conditioning controls to optimize comfort and efficiency in automotive and building environments	K3
CO4	Gain proficiency in diagnosing, maintaining, and servicing air conditioning systems, including troubleshooting, component replacement, and ensuring system integrity through proper testing and maintenance procedures	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3								
CO2	2		2	2								
CO3	1	2			3							
CO4	2		2	2								

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Heating, Ventilation, and Air Conditioning Systems	Jerry Clemons	Cengage Learning	1st Edition, 2010
2	Automotive Air Conditioning: Optimization, Control and Diagnosis	Quansheng Zhang	Springer	1st Edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Air Conditioning and Climate Control Systems	Steven Daly	Butterworth-Heinemann	2016
2	Automotive Technology: A Systems Approach	Jack Erjavec	Cengage Learning	2019
3	Automotive Service: Inspection, Maintenance, Repair	Tim Gilles	Cengage Learning	2019
4	Automotive Climate Control	Patrick W. Freund	Prentice Hall	1st Edition, 2002
5	Automotive Air Conditioning Handbook: Installation, Maintenance & Repair	Jürgen M. Braun	Robert Bosch GmbH	3rd Edition, 2014

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Refrigeration and air-conditioning, IIT Roorkee, Prof. Ravi Kumar https://onlinecourses.nptel.ac.in/noc22_me135/preview

SEMESTER S5

OPERATIONS MANAGEMENT IN AUTO INDUSTRY

Course Code	PEAUT524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with a comprehensive understanding of the fundamental concepts of production and operations management specifically tailored to the automotive industry.
2. To equip students with the skills to strategically plan production activities in automotive manufacturing.
3. To enable students to analyse and manage supply chain operations, apply quality management principles and environmental sustainability practices to enhance efficiency and competitiveness in the automotive sector.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Production and Operations Management, production vs. productivity, the importance of productivity, factors affecting productivity, methods to improve productivity. Work Study: Method Study, Time Study, Importance, Techniques of Work Measurement, Procedure of Conducting. Labour efficiency, methods to improve labour productivity, manpower planning - factors affecting, steps involved, fatigue – causes and remedies, motivation, methods to motivate employees.	9
2	Strategic Planning of Production Activities, Industrial Development, and Life Cycle of a Product. Make or Buy Decision Making: Factors Influencing Make or Buy Decision. Manufacturing Systems Adopted in Car Manufacturing, Overview of Technologies for Materials Applied to the Construction of Vehicles, General Guidelines for Setting Product Design for Automotive Products, Automotive	9

	Industrialization Process Description, Product Data Management (PDM), PDM Analysis, Product Breakdown Structure (PBS), Bill of Material (BOM).	
3	Supply Chain Management: Objectives, Elements of the Supply Chain, Drivers, Activities, Process View of a Supply Chain, Flows in SCM, Factors to be Considered for Developing a Supply Chain, Basic Requirements for Successful SCM, Supply Chain Structure in Automotive Industries. Challenges and Strategies in a Globalized Automotive Market. Key Performance Indicators of Logistics. Production Planning: Forecasting, Capacity Planning, and Aggregate Production Planning. Inventory Management: JIT (Just-In-Time) and Lean Principles in Automotive Manufacturing.	9
4	Quality Management: Total Quality Management (TQM), Six Sigma, and Their Application in Auto Production. Advanced Manufacturing Technologies: Robotics, Automation, IoT (Internet of Things), and AI (Artificial Intelligence) Applications in Automotive Operations. Innovation in Product Development: Design for Manufacturing (DFM), Concurrent Engineering, and Prototyping. Environmental Sustainability: Green Manufacturing Practices and Regulations in the Auto Industry.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	understand the principles of production and operations management, and methods to improve productivity and labour efficiency in the automotive industry.	K2
CO2	understand the strategic planning processes, including make-or-buy decisions and the automotive industrialization process.	K2
CO3	understand the elements and structure of supply chain management, as well as the principles of production planning and inventory management in the automotive industry.	K2
CO4	understand the concepts of quality management and advanced manufacturing technologies, along with innovation and sustainability practices in automotive operations.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-								
CO2	3	2	2	-	2							
CO3	3	3	3	-	2							
CO4	3	2	2	2	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operations management in Automotive industries	Marco Gobetto	Springer	2014
2	Production and Operations management	R Paneerselvam	PHI learning	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Production and Operations Management	S.N. Chary	Tata McGraw-Hill Education	5th Edition, 2019
2	Operations Management for Competitive Advantage	Richard B. Chase, Nicholas J. Aquilano, and F. Robert Jacobs	McGraw-Hill Education	11th Edition, 2006
3	Operations Management	William J. Stevenson	McGraw-Hill Education	13th Edition, 2018
4	Supply Chain Management: Strategy, Planning, and Operation	Sunil Chopra, Peter Meindl, and D.V. Kalra	Pearson Education	6th Edition, 2016
5	Automotive Manufacturing Processes	K. Sridhara Bhat	I.K. International Publishing House 1st Edition, 2013	1st Edition, 2013

Video Links (NPTEL, SWAYAM...)	
	Link ID
	1. Operations Management , By Prof. Inderdeep Singh IIT Roorkee https://onlinecourses.nptel.ac.in/noc20_me30/preview 2. Toyota Production System, By Prof. Rajat Agrawal IIT Roorkee https://onlinecourses.nptel.ac.in/noc24_mg123/preview

SEMESTER S5

ELECTRIC DRIVES AND CONTROLS FOR AUTOMATION

Course Code	PEAUT525	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Comprehend the principles of operation, emf equations, and characteristics of shunt and series excited DC generators and motors, along with their torque-speed equations and industry applications.
2. Understand the principles of transformer operations, including emf equations, vector diagrams, and efficiency calculations, by conducting and interpreting OC and SC tests.
3. Understand the operation principles of single-phase motors and synchronous machines, including their types, regulation methods, and starting mechanisms.
4. Study the operation and control methods of stepper motors and gain insights into various automation controllers, such as servo controls, digital controllers, and programmable logic controllers.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	DC Machines -principle of operation-emf equation-shunt and series excited DC generators. General idea of armature reaction, OCC and load characteristics Principles of series and shunt DC motors-torque and speed equations-torque speed characteristics- Applications of dc shunt series and compound motors. Principles of starting.	9

2	Transformers – principles of operations – emf equation-vector diagrams- losses and efficiency – OC and SC tests. Equivalent circuits- efficiency calculations- maximum efficiency	9
3	Single phase motors - principle of operation of single-phase induction motor – split phase motor – capacitor start motor- Synchronous machines types – emf equation of alternator – regulation of alternator by emf method. Principles of operation of synchronous motors- methods of starting.	9
4	Stepper motors : Principle of operation, variable reluctance motors, Hybrid stepper motors, Linear stepper motor, comparison, Torque-speed characteristics, control of stepper motors Controllers for automation - servo control, Digital controllers, motor controllers, Axis controllers, Machine tool controllers, Programmable Logic Controllers	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the principles and operation, emf equations and characteristics of DC machines to solve practical engineering problems	K3
CO2	Evaluate the performance, effectiveness and efficiency of transformers using vector diagrams and optimise various circuits.	K5
CO3	Grasp the principles of single-phase motors and synchronous machines, including alternator regulation and synchronous motor starting methods	K2
CO4	Understand the principles, characteristics, and control mechanisms of stepper motors and automation controllers, including servo and digital controllers	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2					3						
CO2		2				3						
CO3			2			3						
CO4				2		3						
CO5												

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electrical Machines	Kothari D. P. and I. J. Nagrath .	Tata McGraw Hill	2004
2	The Automotive Transmission Book	Fischer and Pollack	Springer	2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals Of Electric Drives And Control	B.R. Gupta (Author), V.Singhal (Author)	S.K. Kataria & Sons	2013
2	Electrical drives and control	Gnanavadivel	Anuradha agencies	2004
3	Electrical Drives and Control for Automation	R. Resmi, R. Sheeba	Pentagon Educational Services	2013

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Fundamentals of electric drives Prof .shyama prasad das https://youtu.be/QIPJYTeEc_s Application of electric drives in automation ,dr.Shrikrishna n joshi https://youtu.be/CwGizyuUHAY

SEMESTER: S5

AUTOMOTIVE ELECTRICAL LAB

Course Code	PCAUL507	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To provide students with hands-on experience in inspecting, servicing on various electrical circuits associated with automobiles.
2. To equip students with the practical skills necessary for diagnosing, maintaining, and adjusting electrical components such as lights, alternator, battery, starter motor, compressor and battery.
3. To enable students to proficiently perform and interpret diagnostic tests and measurements, using advanced technological systems for electrical systems.

Expt. No.	Experiments
1	Servicing and testing of automobile battery.
2	Servicing and testing of ignition systems.
3	Servicing and testing of viper system and horn.
4	Servicing and testing of lighting systems.
5	Servicing and testing of starter motor.
6	Servicing and testing of alternator used in automobiles.
7	Coil winding of starter motor and alternator.
8	Fault detection testing of wiring harness in automobiles.
9	Experiments using On Board Diagnostic system.
10	Servicing of electric two- wheeler.
11	Servicing and testing of charging systems for electric vehicles.
12	Dynamometer testing for electric two wheelers.
13	Dynamometer testing for IC engine two wheelers.
14	Performance testing of hybrid vehicles.
15	Servicing and maintenance of power window system.

Note: - Minimum 10 Experiments must be carried out

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Students will be able to recall fundamental principles of automotive electrical systems, including the basic operations of batteries, ignition systems, and lighting systems.	K1
CO2	Students will be able to identify and list the components and servicing procedures for various automotive electrical systems, such as the starter motor, alternator, and wiring harness.	K1
CO3	Students will understand the functioning and interrelationships of different automotive electrical components, including how faults in one part can affect the overall system.	K2
CO4	Students will comprehend the diagnostic processes using On Board Diagnostic (OBD) systems and the importance of proper servicing for electric and hybrid vehicles.	K2
CO5	Students will be able to apply their knowledge to perform servicing, testing, and maintenance of various automotive electrical systems, including electric two-wheelers and power window systems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3	2										
CO3	2	3										
CO4	2	3										
CO5	3	2	3	3	3							

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Electrical and Electronic Systems	Tom Denton	Routledge	6th Edition, 2020
2	Automotive Electrical Equipment	P.L. Kohli	Tata McGraw-Hill Education	2nd Edition, 2004
3	Automotive Technology: Principles, Diagnosis, and Service	James D. Halderman	Pearson	6th Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Husain	CRC Press	3rd Edition, 2021
2	Automotive Electronics Handbook	Ronald K. Jurgan	McGraw-Hill Education	2nd Edition, 1999

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Battery Storage and its Applications ; https://youtu.be/AZIS_MCw8Qc Automobile Engineering: https://youtu.be/hs7bABMtOMI

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER: S5

COMPUTER AIDED DESIGN AND ANALYSIS LAB

Course Code	PCAU508	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To introduce students to the basics and standards of engineering design
2. To make students familiarize with different solid modelling and analysis soft wares
3. To convey the principles and requirements of modelling and analysis of machine elements.
4. To introduce the preparation of part modelling and assembly modelling of machineries

Expt. No.	Exercises
1	Creation of high-end part models (Minimum 2 models)
2	Creating assembly models of Socket and spigot joint, Knuckle Joint, Rigid flange couplings, Bushed Pin flexible coupling, Plummer block, Single plate clutch and Cone friction clutch. Pipe joints, Screw jack, Tail stock etc. (Minimum 4 models)
3	Structural Analysis. (Minimum 3 problems)
4	Thermal Analysis. (Minimum 2 problems)
5	Flow Analysis (Minimum 1 problem)

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify in Computer Aided Design and modelling procedures.	K1
CO2	Gain Knowledge in creating solid machinery part	K1
CO3	Gain Knowledge in assembly of machine elements	K2
CO4	Gain Knowledge in finite element analysis	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-		-	-	-	-	2		
CO2	3	-	1	-	-	-	-	-		3		
CO3	3	2	-	-		-	-	-	2	2		
CO4	3	2	-		-	-	-	1	2	3		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CAD/CAM: Principles and Applications	P. N. Rao	Tata McGraw-Hill Education	2010
2	Computer Aided Design and Manufacturing	M. Groover and E. Zimmers	Prentice-Hall India	2010
3	Introduction to Finite Elements in Engineering.	T. R. Chandrupatla and A. D. Belagundu,	Pearson Education,	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A First course in Finite Element Method,	Daryl Logan,	Thomson Learning,	2007
2	Fundamentals of Finite Element Analysis,	David V Hutton,	Tata Mcgraw Hill Publishing	2003

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Computer-Aided Design- https://nptel.ac.in/translation

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 6
AUTOMOBILE ENGINEERING

SEMESTER S6

HYBRID AND FUEL CELL VEHICLES

Course Code	PCAUT601	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the fundamental principles and components of hybrid and fuel cell vehicle technologies, including their energy conversion mechanisms and powertrain configurations.
2. Understand the environmental and societal impacts of hybrid and fuel cell vehicles, comparing their advantages and challenges with conventional internal combustion engine vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to hybrid electric vehicles: Need for hybrid and electric vehicles, components, advantages and disadvantages, application, social and environmental impacts. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies (Series, Parallel, Series – Parallel), power flow control in hybrid drive-train topologies.	11
2	Electric Machines and their controllers: ‘Brushed’ DC Electric Motor - DC regulation and voltage conversion; Brushless Electric Motors - Brushless DC motor, Switched reluctance motors, Induction motor; Motor cooling, efficiency, size and mass. Thermal Management of HEV Power Electronics Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE),	11
3	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Ultra capacitors, Flywheel based energy storage and its analysis, Flywheel Accumulators, Superconducting magnetic energy storage; Hydraulic Accumulators; Hydraulic Pumps/Motors - Pneumatic Hybrid Engine Systems. Energy	11

	management strategies used in hybrid and electric vehicles: types, comparison and implementation issues Hybridization of different energy storage devices	
4	Fuel cell: Fuel Cell based energy storage and its analysis characteristics, types: alkaline fuel cell. Proton exchange Membrane; direct methanol fuel cell. Phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, Hydrogen storage systems - reformers; Fuel cell vehicles.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental need for hybrid and electric vehicles, their components, advantages and disadvantages, applications, and the social and environmental impacts associated with their use.	K2
CO2	Understand various types of electric machines, their controllers, and thermal management strategies in hybrid electric vehicles, emphasizing efficiency, performance, and integration with internal combustion engines.	K2
CO3	Understand various energy storage technologies used in hybrid and electric vehicles, their characteristics, integration challenges, and energy management strategies for optimal performance.	K2
CO4	Understand the operation, characteristics, and applications of different types of fuel cells and their role in energy storage and fuel cell vehicles	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2							
CO2	3	3	3	3	2							
CO3	2	2	2	3	3							
CO4	2	2	2	3	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Kambiz Ebrahimi, Mehrdad Ehsani, Stefano Longo, Yimin Gao	CRC Press	2018
2	Electric and hybrid vehicles	A.K. Babu	Khanna publishers	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hybrid, Electric and Fuel-Cell Vehicles, International Edition	Erjavec Jack	Cengage Learning, Inc	2018
2	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Ehsani Mehrdad	Taylor & Francis Inc	2019

Video Links (NPTEL, SWAYAM...)	
	Link ID
1-4	ELECTRIC VEHICLE INTRODUCTION- PROF.ASHOK JHUNJHUNWALA- https://youtu.be/wypblre9xug
	FUEL CELLS-Prof. ANANDAROOP BHATTACHARYA- https://youtu.be/l2vsoccursk

SEMESTER S6

VEHICLE STABILITY AND DYNAMICS

Course Code	PCAUT602	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the performance characteristics and vibration behaviour of road vehicles, including the effects of tractive resistance, tractive effort, and power requirements
2. Comprehend the dynamics of tires and braking systems, focusing on tire behaviour during cornering, braking dynamics, and the impact of tire characteristics on vehicle performance
3. Analyze the stability of vehicles under various conditions, considering load distribution, gyroscopic effects, and the impact of aerodynamic forces on road loads and vehicle handling

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Performance of road vehicles: Tractive resistance, tractive effort, power required for propulsion, grade ability, drawbar pull and the problems related to these terms. Road performance curves- acceleration, grad ability and drawbar pull. Vibrations-Free vibrations of single degree freedom systems, energy method. Undamped and damped free vibrations, viscous damping, critical damping, logarithmic decrement (Numericals only) transmissibility. Vehicle Vibration and human comforts	9
2	Tires: tire dynamics Ride characteristics, Behavior while Cornering, Slip angle, Cornering force, Power consumed by Tire, Over steer, under steer, steady state cornering, aligning moment-combined braking and Cornering, effect of camber & transient effects in cornering. Tire Vibrations. Braking Dynamics: Braking requirements, stopping distance,	9

	braking efficiency, work done in braking, tire adhesion.	
3	Stability of vehicles: Load distribution (Three wheeled and four wheeled vehicles), Calculation of acceleration, tractive effort and reactions for different drives, stability of a vehicle on a curved track, slope and a banked road. Gyroscopic effects, weight transfer during acceleration, Cornering and braking, cross wind handling.	9
4	Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment, yawing moment, rolling moment, cross wind sensitivity	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of tractive resistance, tractive effort, and power required for vehicle propulsion.	K2
CO2	Understand tire dynamics, including behaviour while cornering and the effects of camber and transient cornering.	K2
CO3	Understand vehicle stability concepts, including load distribution, tractive effort, and gyroscopic effects	K2
CO4	Understand the effects of air resistance on vehicles, including aerodynamic forces and cross wind sensitivity.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		2								
CO2	3	2		2								
CO3	3	2		2								
CO4	3	2		2								

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electrical Machines	Kothari D. P. and I. J. Nagrath .	Tata McGraw Hill	2004
2	Automobile Mechanics	N. K. Giri	Khanna Publishers	8th Edition, 2018
3	The Automotive Transmission Book	Fischer and Pollack	Springer	2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Mechanics	S. Srinivasan	Tata McGraw-Hill	2nd Edition, 2017
2	Vehicle Dynamics and Control	Rajesh Rajamani	Springer	2nd Edition, 2011
3	Theory of Machines and Mechanisms	Sadhu Singh	Pearson Education	4th Edition, 2017

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Fundamentals of Automotive Systems By Prof. C. S. Shankar Ram, IIT Madras

SEMESTER S6

TWO AND THREE WHEELED VEHICLES

Course Code	PEAUT631	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. Learn about different types of two and three-wheelers, including their design, suspension, steering, and powertrain technologies.
2. Gain skills in analysing transmission, drive systems, braking mechanisms, and components of electric vehicles.
3. Develop proficiency in vehicle maintenance, safety standards, and emerging technologies in vehicle design and smart systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Two and Three Wheelers: Types of two and three-wheelers. Frame and chassis design. Suspension systems. Steering systems Powertrain and Engine Technology: Types of engines (two-stroke and four-stroke). Engine components and functions. Fuel systems and carburettors.	9
2	Transmission Systems: Types of transmissions (manual, automatic, and CVT). Clutch systems and operation. Gearbox and gear ratios Drive Systems: Chain, belt, and shaft drives. Differentials and final drive. Braking Systems: Braking systems (drum and disc brakes).	9
3	Electric Two and Three Wheelers: Battery types, Battery Chargers, Charging Port Specifications. Types of electric motors used in two and three-wheel vehicles, Battery Management Systems, Motor Controllers.	9

4	Vehicle Maintenance: Routine maintenance and servicing. Common troubleshooting and repair techniques Safety Systems and Regulations: Retrofitting of IC engines to EV in two/three wheelers. Safety standards and regulations. Rider safety gear and ergonomics Emerging Technologies: Advanced materials and lightweight construction. Smart and connected vehicle technologies.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the design, suspension, steering systems, and engine types of two and three-wheelers.	K2
CO2	Understand transmission types, clutch systems, drive systems, and braking mechanisms.	K2
CO3	Understand components of electric vehicles, including batteries, chargers, motors, and controllers.	K2
CO4	Apply maintenance practices, understand safety standards, retrofitting, and evaluate emerging vehicle technologies.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	3	2	1								
CO3	3	2	3	2	1							
CO4	2	2	3	3	2	1						

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Textbook of Automobile Engineering	R.K. Rajput	Laxmi Publications	2nd Edition, 2017
2	Two and Three Wheelers	D. Sathya Prasad	New Age International Publishers	2nd Edition, 2018
3	Automobile Engineering Vol. 1	Kirpal Singh	Standard Publishers Distributors	13th Edition, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Vehicle Dynamics	Thomas D. Gillespie	SAE International	Indian Edition, 2010
2	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Husain	CRC Press	Indian Edition, 2010
3	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi	CRC Press	Indian Edition, 2017

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Introduction to Automotive Engineering: https://archive.nptel.ac.in/courses/107/106/107106088/ Automotive Chassis and Body Engineering: https://archive.nptel.ac.in/courses/107/106/107106088/ Fundamentals of Automotive Systems and Engine Design: https://archive.nptel.ac.in/courses/107/106/107106088/ (Covers transmission systems, clutches, gearboxes, and drive systems) Electric Mobility and Manufacturing: https://swayam.gov.in/explorer (Explores electric vehicle technology, including batteries, motors, and battery management systems) Electric Vehicles and Renewable Energy Integration: https://archive.nptel.ac.in/courses/108/106/108106182/ (Provides an understanding of electric vehicle technology and its integration with renewable energy sources) Government of India Ministry of New and Renewable Energy (MNRE): https://heavyindustries.gov.in/sites/default/files/2023-07/NEMMP-2020.pdf (Information on Indian government initiatives on electric vehicles)

SEMESTER S6

AUTONOMOUS DRIVING AND ADAS

Course Code	PEAUT632	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the principles and components of autonomous driving and ADAS technologies.
2. To explore the various sensor technologies and their integration into autonomous and ADAS systems.
3. To analyse the role of AI, machine learning, and software platforms in autonomous driving.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Autonomous Driving - Levels of vehicle autonomy (SAE levels 0-5), Key components of autonomous vehicles , Overview of autonomous vehicle architectures Advanced Driver Assistance Systems (ADAS) Overview - Definition and objectives of ADAS, Key ADAS features: Lane keeping assist, adaptive cruise control, automated parking, Benefits and challenges of ADAS Vehicle Communication and Networking - In-vehicle networking (CAN, LIN, FlexRay), Vehicle-to-everything (V2X) communication , Role of wireless technology in autonomous driving. Regulatory and Ethical Considerations- Legal aspects of autonomous driving , Ethical considerations and safety standards Current regulations and future trends	9
2	Radar and Lidar Systems - Basics of radar technology, Applications and limitations of radar in vehicles, Fundamentals of Lidar technology,	9

	Lidar applications in 3D mapping and obstacle detection Camera Systems and Image Processing - Types of cameras used in ADAS , Image processing techniques for vehicle safety, Night vision technology and applications. Ultrasonic and Infrared Sensors - Principles of ultrasonic sensor operation, Applications in parking assist and obstacle detection Infrared sensors and their role in ADAS Sensor Data Fusion - Introduction to sensor data fusion, Techniques for combining data from different sensors, Benefits of sensor fusion in enhancing system accuracy and reliability	
3	Artificial Intelligence and Machine Learning - Role of AI in autonomous vehicles , Machine learning algorithms for vehicle perception and decision-making, Deep learning applications in autonomous driving. Autonomous Driving Platforms and Software - Overview of autonomous driving software architectures, Key platforms: ROS (Robot Operating System), Autoware, Apollo, Software development and simulation tools. Path Planning and Control Systems - Fundamentals of path planning algorithms, Control systems for vehicle stability and navigation, Real-time decision-making, and obstacle avoidance Cloud Computing and Edge Processing - Role of cloud computing in autonomous vehicle ecosystems, Edge processing for real-time data handling, Examples of cloud-based autonomous driving platforms	9
4	System Integration and Calibration - Integration of ADAS components into vehicle systems, Calibration techniques for sensors and actuators, Challenges in system integration Testing and Validation - Testing methodologies for autonomous and ADAS systems, Simulation environments and test tracks, Validation processes and safety assessments Maintenance and Troubleshooting - Common issues in ADAS and autonomous systems, Diagnostic tools and software, Maintenance best practices for autonomous vehicles	9

	Case Studies and Future Trends- Case studies of leading autonomous vehicle projects, Emerging trends in autonomous driving and ADAS technology, Future directions and research opportunities	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic control system theory, ECU operation, concepts of cyber-physical control systems, remote sensing technology, and wireless networks in the context of vehicle autonomy.	K2
CO2	Understand the moral, legal, technical, and security issues surrounding driverless car technology, and the role of artificial intelligence and deep learning in autonomous vehicles, including AI-based functions and cloud-based driving platforms.	K2
CO3	Integrate and calibrate sensor and control systems in autonomous and ADAS technologies.	K3
CO4	Apply AI and machine learning techniques to enhance vehicle perception and decision-making.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	2							
CO2	3	3	2	2	0							
CO3	3	–	3	2	3							
CO4	3	2	–	–	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Autonomous Vehicles Technologies, Regulations, and Societal Impacts	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos	Elsevier Publications	2021
2	Dietmar P.F. Möller, Roland E. Haas,	Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies	Springer Publications	2019
3	Hanky Sjafrie	Introduction to Self-Driving Vehicle Technology	Chapman and Hall/CRC	1st Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Wireless Telecommunications Systems and Networks	Gary J. Mullett	Thomson–Delmar Learning	2006
2	Basic Telecommunications: The Physical Layer	Gary J. Mullett	Thomson–Delmar Learning	2003
3	Automobile Electrical and Electronic Systems	Tom Denton	Elsevier Publications	3rd Edition 2004

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Introduction to Self-Driving Cars, University of Toronto, Steven Waslander, Jonathan Kelly https://www.coursera.org/lecture/intro-self-driving-cars/welcome-to-the-self-driving-cars-specialization-9l23h Visual Perception for Self-Driving Cars, University of Toronto, Steven Waslander, Jonathan Kelly https://www.coursera.org/lecture/visual-perception-self-driving-cars/welcome-to-the-self-driving-cars-specialization-40vEZ

SEMESTER S6

VEHICLE TRANSPORT AND FLEET MANAGEMENT

Course Code	PEAUT633	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of the principles and practices of vehicle transport and fleet management.
2. To equip students with the skills necessary to manage and optimize fleet operations, including maintenance, fuel management, and safety compliance.
3. To introduce advanced technologies and strategic planning techniques used in modern fleet management to enhance efficiency and sustainability.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Vehicle Transport - Overview of vehicle transport systems, Types of transport vehicles (commercial, public, private), Role of vehicle transport in the economy Fleet Management Basics - Definition and scope of fleet management, Objectives and importance of fleet management, Components of fleet management systems Vehicle Acquisition and Leasing - Methods of vehicle acquisition (purchase, lease, hire), Cost-benefit analysis of different acquisition methods, Fleet financing options Vehicle Life Cycle Management - Phases of vehicle life cycle, Strategies for extending vehicle life, Disposal and resale of vehicles	9
2	Fleet Operations - Fleet scheduling and routing, Trip planning and management, Driver management and training	9

	Vehicle Maintenance Management - Preventive vs. corrective maintenance. Maintenance scheduling and record keeping. Use of telematics in maintenance Fuel Management - Fuel procurement and storage , Fuel consumption monitoring , Strategies for reducing fuel costs Safety and Compliance - Regulatory requirements for fleet operations, Safety management systems, Accident management and reporting	
3	Fleet Management Software - Types of fleet management software, Features and functionalities, Benefits of using fleet management software Telematics and GPS Tracking - Introduction to telematics, GPS tracking systems and their applications, Benefits of telematics in fleet management Data Analytics in Fleet Management - Importance of data analytics , Key performance indicators (KPIs) for fleets Using data for decision making Automation and Future Trends - Electric and hybrid vehicles in fleets, Autonomous vehicles in fleet management, Emerging trends in fleet management technology, case studies.	9
4	Fleet Planning and Optimization - Strategic fleet planning, Fleet optimization techniques, Route optimization and load planning Cost Management in Fleet Operations - Cost components of fleet management, Cost control strategies, Budgeting, and financial planning for fleets Environmental Considerations - Environmental impact of fleets, Strategies for reducing environmental footprint, green fleet management practices Case Studies and Best Practices - Analysis of successful fleet management practices, Case studies of leading fleet operations, Lessons learned and best practices in fleet management	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the components and objectives of fleet management systems.	K2
CO2	Understand the regulatory and safety requirements for fleet operations.	K2
CO3	Apply maintenance and fuel management strategies to optimize fleet operations.	K2
CO4	Utilize fleet management software and telematics for data-driven decision making in fleet management	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2	3	2								
CO4	3	2	3	2	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Vehicle Transport Management	S.L. Bhandarkar	Dhanpat Rai & Co.	-
2	The ultimate guide to commercial vehicle fleet management	David Wilson	DW Consultancy	2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Indian Commercial Transport Handbook	Pradeep Yadav	Five Minute Transporter	2020
2	Lowe's Transport Manager's and Operator's Handbook 2021	David Lowe, Glen Davies		2021
3	Fleet Management System -A Complete Guide		The Art of Service - Fleet Management System Publishing	2020
4	Profitable Fleet Management: For Small and Medium Businesses	Bill DeBoer		2023

SEMESTER S6

VEHICLE MAINTENANCE

Course Code	PEAUT635	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of vehicle maintenance principles and practices for conventional, electric, and hybrid vehicles.
2. To equip students with practical skills for diagnosing, servicing, and maintaining various vehicle systems and components.
3. To familiarize students with advanced diagnostic tools, safety practices, and emerging trends in vehicle maintenance technology.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Vehicle Maintenance - Importance and objectives of vehicle maintenance, Types of maintenance: Preventive, predictive, and corrective, Preparation of maintenance schedules and checklists, Record keeping and documentation Advanced Diagnostics - Use of advanced diagnostic tools and software, Common sensor errors and rectification methods, Emerging trends in vehicle maintenance technology Safety in Vehicle Maintenance - General safety guidelines, Use of personal protective equipment (PPE), Tool safety and safe handling of hazardous materials	9
2	Engine Maintenance - Routine maintenance of petrol and diesel engines, Scheduled maintenance services for different operating conditions, Inspection and replacement of drive belts, spark plugs, and valve adjustments, Cooling and lubrication systems maintenance	9

	Transmission Maintenance - Types of transmissions: Manual, automatic, AMT, CVT, DSG , Common problems and maintenance procedures , Clutch maintenance: Inspection, adjustment, and replacement , Gearbox maintenance: Inspection, adjustment, and repair Brake Maintenance - Types of brake systems: Hydraulic, mechanical, ABS, Brake inspection, cleaning, adjustment, and replacement, Brake bleeding procedures , Troubleshooting common brake issues	
3	Body and Chassis Maintenance - Body repair tools and techniques: Tinkering, painting, soldering, and metalloid paste application, Tyre and wheel maintenance: Rotation, balancing, and alignment , Suspension system: Service, repair, and overhauling , Steering system: Service, repair, and overhauling Electrical System Maintenance - Battery maintenance: Inspection, testing, and replacement , Charging and starting system maintenance , Lighting system maintenance , Electrical wiring and connector inspection and repair	9
4	Electric Vehicle (EV) Maintenance - Introduction to electric vehicles and their components, Routine and scheduled maintenance of EVs, Maintenance of high voltage battery, motor, inverter, On-Board Charger (OBC), and reduction gear, Safety precautions in handling high voltage systems Hybrid Vehicle Maintenance - Introduction to hybrid vehicles and their components, Maintenance of hybrid drive systems: Engine, electric motor, battery, and control systems Inspection and servicing of regenerative braking systems, Troubleshooting common hybrid vehicle issues	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the importance, types, and safety aspects of vehicle maintenance.	K2
CO2	Understand the maintenance requirements and procedures for electric and hybrid vehicles.	K2
CO3	Analyse troubleshooting's, maintenance tasks on engines, transmissions, brake systems, and other vehicle components.	K4
CO4	Using suitable diagnostic tools and softwares, evaluate various errors in vehicle systems and develop rectification techniques.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										2
CO2	3	3			2							2
CO3	3	3	3		2							2
CO4	3	3	3	2	3							2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Engineering Volume 1 & 2	Kirpal Singh	Standard Publishers	2013
2	Automotive Mechanics	William H. Crouse, Donald L. Anglin	McGraw Hill	2017
3	Automotive Handbook	Bosch	Bentley Publishers	2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Mechanical and Electrical Systems	Tom Denton	Routledge	2011
2	Automotive Maintenance and Light Repair	James D. Halderman	Pearson	2014
3	Automotive Mechanics	Joseph Heitner	-	2010
4	Automotive Wiring and Electrical Systems	Tony Candela	CarTech Inc	2009

SEMESTER S6

AUTOMOTIVE COMPONENT DESIGN

Course Code	PBAUT604	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To Understand the fundamentals of design, including the design process, preferred numbers, standards, codes, and material properties, and their behaviour under various stresses.
2. To Analyse different theories of failure, shock and impact loads, fatigue loading, and factors affecting endurance limits and safety.
3. To Design mechanical components such as shafts, bearings, springs, gears, clutches, brakes, and internal combustion engine parts, considering their material properties, loading conditions, and failure mechanisms.
4. To Apply principles of lubrication, bearing selection, gear design, and the impact of static and dynamic loads on mechanical systems to ensure efficient and reliable performance.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Design- Definition, steps in design process, preferred numbers, standards, and codes in design. Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour, shear, bending and torsional stresses, combined stresses, stress concentration factor. Theories of Failure- Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, and Von Mises and Hencky Theory. Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, factor of safety.	9

	Shafting- material, design considerations, causes of failure in shafts, design based on strength, rigidity and critical speed, design for static and fatigue loads, repeated loading, reversed bending. Suggestions-problem project- Students can explore innovative approaches to design processes, integrating preferred numbers, standards, and codes into practical design solutions.	
2	Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load. Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommer field number, design considerations. Springs- classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, end construction. Leaf springs- Flat springs, semi elliptical laminated leaf springs, design of leaf springs. Suggestion-problem project -students will have the autonomy to explore and design bearing and spring systems based on specified performance criteria and real-world applications. The project will integrate concepts from rolling contact bearings, sliding contact bearings, and springs, focusing on design considerations, material selection, and performance analysis.	9
3	Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (review only), virtual or formative number of teeth, gear tooth failures, Beam strength, Lewis equation, Buckingham's equation for dynamic load, wear load, endurance strength of tooth, surface durability, heat dissipation – lubrication of gears – Merits and demerits of each type of gears. Design of spur gear and helical gear. Suggestion- discipline project- students will explore the design and analysis of gear systems, focusing on both spur gears and helical gears. The project will involve studying gear classification, nomenclature, tooth profiles, materials selection, and gear failure	9

	modes. Students will apply theoretical concepts such as the Law of Gearing, virtual number of teeth, and gear tooth strength calculations.	
4	Clutches – friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch. Brakes - Block brakes, band brake, Internal expanding shoe brake. Design of Internal combustion engine parts- Piston, Cylinder, Connecting rod and Flywheel. Suggestion – discipline project- students will explore various aspects of clutch systems, integrating knowledge from clutches, brakes, and the design of internal combustion engine parts. The project will involve both theoretical exploration and practical application, aligning with the discipline Project model where students have the freedom to choose specific aspects to explore within the defined theme.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand the fundamental principles of the design process, including material selection and adherence to standards and codes.	K2
CO2	To apply different failure theories to predict and analyse the behaviour of mechanical components under various loads.	K3
CO3	To design and analyse mechanical components like shafts, bearings, springs, and gears considering factors such as strength, rigidity, and load capacity.	K2
CO4	To develop practical skills in designing engine parts and transmission systems, ensuring reliability and durability under different loading conditions.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1						
CO2	2	3	3	2	2	2						
CO3	2	2	2	1	1	1						
CO4	2	3	2	2	2	2						

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Component Design	Dilip M. Kupade, Shivaji S. Aher	Nirali Prakashan	2019
2	Design Of Machine Elements	V B Bhandari	Mc.graw Hill Education India Private Limited	2017
3	A Text Book on Machine Design	R S Khurmi, J.Guptha	S.Chand Limited	1987
4	Machine Design	Jindal	Pearson Education India	2010
5	Design data book	K.Mahadevan, Balaveera.k.reddy	CBS Publishers & Distributors	2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile technology	n.k. giri	khanna publishers	2004
2	Design of machine elements	k.ganesh babu	mcgraw-hill education (india) pvt limited	2010

Video Links (NPTEL, SWAYAM...)	
	Link ID
	AUTOMOBILE COMPONENT DESIGN ,PROF.Neerav Mehta, https://youtu.be/rRqWebHC2kc?list=PLQmc-I2-FO2G4oYtYXKOFXYPh90lvF6Ny AUTOMOBILE COMPONENT DESIGN ,Prof. Ripal gole,Prof.Priyank patel , https://youtu.be/KqFWzG2iU2w?list=PL-dKnM2vz8NKvuAfeKVDwI2iyTBS0IlAT

SEMESTER S6

DESIGN THINKING AND PRODUCT DEVELOPMENT

(Common to Group C & Group D)

Course Code	GZEST605	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	60
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To guide students through the iterative stages of design thinking, including empathizing with users, defining problems, ideating solutions and developing Proof of Concepts (PoC) and technical feasibility studies.
2. To promote the development of critical thinking skills by engaging students in integrative inquiry, where they ask meaningful questions that connect classroom knowledge with real-world applications.
3. To equip students with the ability to involve in product design considering the sustainability, inclusivity, diversity and equity aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of design thinking and product development: Overview of stages of product development lifecycle; Design thinking -Definition-Design thinking for product innovation; Bringing social impact in ideation-Identifying societal needs-understanding multi-faceted issues-community engagement and empathetic design- technological innovation meeting societal needs; Understanding and Bridging the divide using Human Centered Design (HCD); Designing for inclusivity in product development-embracing user diversity - Long term impact - sustainability encompassing environmental,economic and social dimensions; Technology Readiness Level in the Innovation Life-cycle; Performing a self-check on innovative ideas - Originality of idea-understanding innovation landscape - patentability - understanding the	6

	economic landscape - Unique Selling Proposition (USP) - Repeatability and Manufacturability - Sustainability - Leveraging business models for comprehensive analysis	
2	Empathize: Design thinking phases; Role of empathy in design thinking; Methods of empathize phase - Ask 5 Why/ 5 W+H questions; Empathy maps - Things to be done prior to empathy mapping - Activities during and after the session; Understanding empathy tools - Customer Journey Map - Personas. Define: Methods of Define Phase: Storytelling, Critical items diagrams, Define success.	6
3	Ideation : Stages of ideation; Techniques and tools - Divergent thinking tools - Convergent thinking tools - Idea capturing tools; Cross-industry inspiration; Role of research in ideation - Market research - consumer research - leveraging research for informed ideation; Technological trends - navigating the technological landscape - Integrating emerging technologies; Feasibility studies - technical, economic, market, operational, legal, and ethical feasibility; Ideation session- techniques and tips. Proof of Concept (PoC) : Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation	6
4	Design: Navigating from PoC to detailed design; Developing Specification Requirement Document (SRD); Design for manufacturability; Design to cost; Pre-compliance; Design Failure Mode and Effects Analysis (DFMEA); Forecasting future design changes. Prototyping: Alpha prototypes; Beta prototypes; Transition from design to prototype; Goals and expectations for Alpha and Beta prototypes; Effective strategies for maintaining timeline in prototyping; Testing and refining Alpha prototypes; Transitioning to Beta prototypes. Pilot build: Definition and purpose of a pilot build; setting objectives; Identification and selection of manufacturing partner for pilot build; Testing procedures in pilot build; Scaling from pilot build to full-scale production / implementation.	6

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	K5
CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	K6
CO3	Engage in Human Centric Design of innovative products meeting the specifications	K5
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	K4
CO5	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		2	3	3	3	2	2		3
CO2	3	2	3		2	3	3	3	2	2		3
CO3	3	2	3		2	3	3	2	2	2		3
CO4	3	2	2		3	3	3	2	2	2		3
CO5	3					3	3	2	2	2		3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	HarperCollins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

1. Evaluate and prepare a report on how the aspects including inclusivity, diversity and equity are taken into consideration during the empathize and define phases of the Miniproject course.
2. Evaluate and prepare a report on how the aspects including sustainability, inclusivity, diversity and equity are taken into consideration during the ideate phase of the Miniproject course.
3. Evaluate and prepare a report on how User-Centric Design (UCD) is used in the design and development of PoC of the product being developed in the Miniproject course.
4. Prepare a plan for the prototype building of the product being developed in the Miniproject course.
5. Report on the activities during the empathize phase including the maps & other materials created during the sessions.
6. Report on the activities during the define phase including the maps & other materials created during the sessions.

SEMESTER S6

AUTOMATED GUIDED AND AUTONOMOUS VEHICLES

Course Code	OEMUT611	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the principles and components of AGV and autonomous vehicle technologies.
2. To explore the various sensor technologies and their integration into AGV and autonomous systems.
3. To analyse the role of AI, machine learning, and software platforms in AGV and autonomous driving

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Autonomous Driving - Levels of vehicle autonomy (SAE levels 0-5), Key components of autonomous vehicles, Overview of autonomous vehicle architectures Automated Guided Vehicles (AGV) Overview - Definition and applications of AGVs, Types of AGVs: Tugger, Unit Load, Forklift, Key components of AGVs Vehicle Communication and Networking - In-vehicle networking (CAN, LIN, FlexRay), Vehicle-to-everything (V2X) communication, Role of wireless technology in autonomous driving Regulatory and Ethical Considerations- Legal aspects of autonomous driving, Ethical considerations and safety standards, Current regulations and future trends	9
2	Radar and Lidar Systems - Basics of radar technology, Applications and limitations of radar in vehicles, Fundamentals of Lidar technology, Lidar	

	applications in 3D mapping and obstacle detection Camera Systems and Image Processing - Types of cameras used in ADAS and AGVs, Image processing techniques for vehicle safety, Night vision technology and applications Ultrasonic and Infrared Sensors - Principles of ultrasonic sensor operation, Applications in parking assist and obstacle detection Infrared sensors and their role in ADAS and AGVs Sensor Data Fusion - Introduction to sensor data fusion, Techniques for combining data from different sensors, Benefits of sensor fusion in enhancing system accuracy and reliability	9
3	Artificial Intelligence and Machine Learning - Role of AI in autonomous vehicles and AGVs, Machine learning algorithms for vehicle perception and decision-making, Deep learning applications in autonomous driving Autonomous Driving Platforms and Software - Overview of autonomous driving software architectures, Key platforms: ROS (Robot Operating System), Autoware, Apollo, Software development and simulation tools Path Planning and Control Systems - Fundamentals of path planning algorithms, Control systems for vehicle stability and navigation, Real-time decision-making and obstacle avoidance Cloud Computing and Edge Processing - Role of cloud computing in autonomous vehicle ecosystems, Edge processing for real-time data handling, Examples of cloud-based autonomous driving platforms	9
4	System Integration and Calibration - Integration of ADAS and AGV components into vehicle systems, Calibration techniques for sensors and actuators, Challenges in system integration Testing and Validation - testing methodologies for autonomous and AGV systems, Simulation environments and test tracks, Validation processes and safety assessments Maintenance and Troubleshooting - Common issues in ADAS, AGV, and autonomous systems, Diagnostic tools and software, Maintenance best practices for autonomous vehicles and AGVs Case studies of leading autonomous vehicle and AGV projects, Emerging trends in autonomous driving and AGV technology	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the fundamental concepts and components of AGV and autonomous vehicle technologies.	K2
CO2	Understand the principles and applications of various sensor technologies used in AGV and autonomous systems.	K2
CO3	Integrate and calibrate sensor and control systems in AGV and autonomous vehicle technologies.	K3
CO4	Apply AI and machine learning techniques to enhance vehicle perception and decision-making.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	2	–	–	–	–	–	–	–
CO2	3	3	2	2	0	–	–	–	–	–	–	–
CO3	3	–	3	2	3	–	–	–	–	–	–	–
CO4	3	2	–	–	3	–	–	–	–	–	–	–

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Autonomous Vehicles Technologies, Regulations, and Societal Impacts	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos	Elsevier Publications	2021
2	Dietmar P.F. Möller, Roland E. Haas,	Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies	Springer Publications	2019
3	Hanky Sjafrie	Introduction to Self-Driving Vehicle Technology	Chapman and Hall/CRC	1st Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Wireless Telecommunications Systems and Networks	Gary J. Mullett	Thomson–Delmar Learning	2006
2	Basic Telecommunications: The Physical Layer	Gary J. Mullett	Thomson–Delmar Learning	2003
3	Automobile Electrical and Electronic Systems	Tom Denton	Elsevier Publications	3rd Edition 2004

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Introduction to Self-Driving Cars, University of Toronto, Steven Waslander, Jonathan Kelly https://www.coursera.org/lecture/intro-self-driving-cars/welcome-to-the-self-driving-cars-specialization-9l23h
2	Visual Perception for Self-Driving Cars, University of Toronto, Steven Waslander, Jonathan Kelly https://www.coursera.org/lecture/visual-perception-self-driving-cars/welcome-to-the-self-driving-cars-specialization-40vEZ

SEMESTER S6

MODERN AUTOMOTIVE TECHNOLOGIES

Course Code	OEMUT612	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the modern technologies automotive technologies like Electric, hybrid and fuel cell vehicle technology, different components associated with these systems.
2. To understand the various ADAS technologies such as adaptive cruise control, lane-keeping assist, and automated parking systems.
3. To understand the automobile navigation systems, connected vehicles and autonomous driving cars.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Electric and Hybrid Vehicle technology: Introduction, LEV, TLEV, ULV & ZEV, Basic components of Electric vehicles- Inverters, Battery packs and battery management system, motors, electronic power control unit, Electric wiring harness – CAN Bus, Multiplex wiring. regenerative braking, basic factors to be considered for converting automobiles to electric vehicle, hybrid electric vehicle, types - series and parallel hybrid, layouts, comparison, Power systems and control systems, Different modes of operation of hybrid vehicles for best performance.	9
2	Recent Trends in Automotive Power Plants: Stratified charged / lean burn engines – TSI engines, RCCI engines, Hydrogen Engines, Flex fuel vehicles. Vehicle Operation and engine Control: Application of sensors and actuators and microprocessors for operation of the vehicle	9

	to achieve best fuel economy, reduced emission and optimum road performance, Closed loop and open loop operation, electronic engine management systems, Electronic cruise control, chassis control system, Integrated systems.	
3	Principle of automobile navigation and controls in the new generation cars- capabilities of navigation and control of modern cars. Driver Assistance Systems in Automobiles: Vision in cars, A comprehensive driver assistance approach – Lane recognition, Traffic sign recognition, road recognition, Object recognition – Traffic lights and signals.	9
4	Fuel Cells and Alternative energy systems: Introduction to fuel cells, Operational fuel cell voltages, Proton Exchange membrane fuel cells, Alkaline Electrolyte fuel cells, Medium and high temperature fuel cells, fuel and fuel chose, fuel processing, fuel cell stacks, Delivering fuel cell power, Integrated Air supply and humidification concepts for fuel cell systems, Fuel cell Auxiliary systems.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the construction and working of different electric and Hybrid Vehicle technology.	K2
CO2	Exemplify the significance of alternate power plants for automobiles and different modes of operation for optimum use.	K2
CO3	Understand the navigation and driver assistance systems used in modern vehicles.	K2
CO4	Understand the construction and working of different types of fuel cells and auxiliary systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	2	-	1	1	-	-	2	-	1
CO2	2	1	-	2	-	1	2	-	-	2	-	1
CO3	2	1	-	1	-	1	1	-	-	2	-	1
CO4	2	1	-	2	-	2	2	-	-	2	-	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Electricity, Electronics and Computer Controls	Barry Hollembeak	Delmer Publishers	1 st edition, 1998
2	Build Your Own Electric Vehicle	Bob Brant	McGraw-Hill	2013
3	Bosch Hand Book, 3rd Edition	SAE	SAE international	1993

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Electric and Hybrid Electric and Fuel Cell Vehicles	Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi	CRC press, A Taylor and Francis group	2018
2	Autonomous driving and advanced driver-assistance systems (ADAS)	Lenin Joseph, Amit Kumar Mondal	CRC press, A Taylor and Francis group	2021
3	Fuel Cell Power for Transportation	Prodip K. Das, Kui Jiao, Yun Wang, Barbir Frano	SAE International	2023
4	Modern Automotive Technology	James E Duffy	SAE International	2013
5	Noise Reduction	Beranek. L. L	McGraw-Hill Book Co, Inc, New York	1993

SEMESTER S6

SPECIAL TYPES OF VEHICLES

Course Code	OEMUT614	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Comprehend the design and functionality of various special types of vehicles, including their unique features and applications.
2. Analyse the operational principles and maintenance requirements of special vehicles used in different industries.
3. Develop problem-solving skills for troubleshooting and optimizing the performance of special types of vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Tyre and tracked vehicles, advantages and disadvantages, undercarriage of tracked vehicle - tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. Suspension and steering of tyre and tracked vehicle Final drives: types of reductions like, single reduction, double reduction final drive and planetary final drives, PTO shaft, Basic components of hydraulic systems like pumps (types of pumps), control valves like flow control valves, directional control valves and pressure control valves, hydraulic motors and hydraulic cylinders.	9
2	Tractors: General description, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled-bulldozers, tilt dozers and angle dozers, front end loaders, Productivity & operating capacity of dozer.	9

	Excavators: General description, classification based on attachments, face shovel, drag shovel, hoe, drag-line and grab or clam shell, advantages and limitations.	
3	Haulage vehicles: General description, specification and functions, self-propelled and tractor towed haulage vehicles, dumpers – front tipping; trucks – rear tipping, tractor towed semi-trailers and trailers (rear and side tipping, bottom dumping). Graders: Description, classification and functions of graders, functional details of spreading, mixing, ditching, bank sloping, snow removal, stripping, scarifying, and finishing. Scrapers: General description, classification- tractor towed and motorized scrapers, scraper loading – back track and chain track loading, operations - scraper work in cutting, cambering, side hill cutting, spreading on embankments	9
4	Cranes: General description, specifications and functions, excavator mounted cranes, mobile cranes with strut and cantilever type jibs, tractor towed and tractor mounted cranes. Lift trucks: General description, specification and functions, fork lift trucks, alternative front end equipment (attachments) – jib arm, shovel bucket, squeeze clamp, boom, fork extensions, barrel forks. Scissors lift trucks - applications in industry, advantages and disadvantages. Compaction vehicles: General description, specification and functions, smooth wheeled rollers, pneumatic tired rollers, agricultural Rollers, sheep's foot rollers; vibrating compactors.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the components and operational principles of tyre and tracked vehicles, including their suspension and steering systems.	K2
CO2	Understand the specifications, functions, and productivity of different types of special vehicles such as tractors, excavators, haulage vehicles, graders, scrapers, cranes, and compaction vehicles.	K2
CO3	Apply knowledge of hydraulic systems and final drives to analyse and troubleshoot special vehicles.	K3
CO4	Evaluate the productivity and operational capacity of various special vehicles through practical examples and case studies.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									1
CO2	3	2	2									1
CO3	3	3	2	2								1
CO4	3	3	2	2								1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Construction Equipment and Methods	Robert L. Peurifoy, Clifford J. Schexnayder, Aviad Shapira	McGraw-Hill Education	7th Edition, 2018
2	Heavy Equipment Operations	John Deere	John Deere Publishing	1st Edition, 2016
3	Hydraulic Systems for Mobile Equipment	Timothy W. Dell	Goodheart-Willcox	2nd Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Construction Equipment	Frank Harris, Ronald McCaffer	Wiley-Blackwell	1st Edition, 2013
2	Earthmoving Equipment Operation	Deere & Company	Deere & Company	1st Edition, 2014
3	Fundamentals of Mobile Heavy Equipment	Owen C. Duffy	CDX Automotive	1st Edition, 2019
4	Maintenance Fundamentals for Heavy Equipment	Paul D. Tomlinson	Elsevier	1st Edition, 2010

SEMESTER: S6

AUTOTRONICS LAB

Course Code	PCAUL607	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To provide students with hands-on experience in inspecting, servicing on various electronics circuits associated with automobiles.
2. To equip students with the practical skills necessary for diagnosing, maintaining, and adjusting electronics associated with automobiles.
3. To enable students to proficiently perform and interpret diagnostic tests and measurements, using advanced technological systems for electronic systems.

Expt. No.	Experiments
1	Testing of various sensors used in automobiles.
2	Testing and validation of logic gate ICs using ARDUINO.
3	Testing and validation of flip flops using ARDUINO.
4	Testing of Diodes, Transistor, Op-amps, Relays in automotive electronic circuits.
5	Testing and validation of flip flops.
6	Programming and interfacing of Microcontrollers/Microprocessors
7	Interfacing of AC/DC converter, stepper motor and dc motor.
8	Advanced On-board diagnostics (OBD) and fault detection in electronics circuits.
9	Familiarization of engine remapping tools and software
10	Design and testing of the circuit for keyless entry, parking system.
11	Design and testing of the circuits for ABS, EBD and Traction Control.
12	Design and testing of circuit for electronic triggering equipment
13	MAT lab simulation for various electronic circuits (RLC circuit)
14	Study and testing of steer by wire technology.
15	Testing of NVH levels of an automobile.

16	Emission testing of an automobile using sensors.
17	Testing and diagnostics of inverters used in electric vehicles.
18	Testing of regenerative braking systems in electric and hybrid vehicles.
19	Understanding and diagnosing Controller Area Network (CAN) bus systems used in modern vehicles.
20	Calibration and testing of systems such as adaptive cruise control, lane departure warning, and automatic emergency braking.
21	Testing and validation of electric vehicle powertrains including motors, controllers, and power electronics.
22	Understanding and testing vehicle telematics systems, including GPS, infotainment, and vehicle-to-everything (V2X) communication.

Note:- A Minimum of 12 Experiments is necessary.

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Students will be able to recall the fundamental concepts and principles of various sensors and electronic components used in automobiles.	K1
CO2	Students will identify and describe the functionality of logic gate ICs, flip flops, and microcontrollers/microprocessors used in automotive applications.	K1
CO3	Students will understand the interfacing and programming techniques for microcontrollers/microprocessors and their applications in automotive systems.	K2
CO4	Students will comprehend the operation and testing methods of advanced automotive systems like OBD, CAN bus, and engine remapping tools.	K2
CO5	Students will be able to design, test, and validate automotive electronic circuits and systems, including those for keyless entry, ABS, regenerative braking, and vehicle telematics.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3	2										
CO3	2	3										
CO4	2	3		2								
CO5	3	2	3	3	3							

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Electronics Handbook	Ronald K. Jorgen	McGraw-Hill Education	2nd Edition, 1999
2	Automotive Sensors	John Turner	Momentum Press	1st Edition, 2009
3	Digital Electronics: Principles and Applications	Roger L. Tokheim	McGraw-Hill Education	8th Edition, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Power Electronics: Circuits, Devices & Applications	Muhammad H. Rashid	Pearson	4th Edition, 2013
2	Automotive Diagnostic Systems: Understanding OBD-I & OBD-II	Keith McCord	Motorbooks	1st Edition, 2011
3	MATLAB for Engineers	Holly Moore	Pearson	5th Edition, 2018

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Programming and interfacing of Microcontrollers/Microprocessors.; https://youtu.be/MqWeH3zp5GY Testing and validation of electric vehicle powertrains including motors, controllers, and power electronics. : https://youtu.be/gDOnBwjF55U

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.

- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 7
AUTOMOBILE ENGINEERING

SEMESTER S7

VEHICLE BODY ENGINEERING

Course Code	PEAUT741	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding on vehicle body design and classification
2. To equip students to analyse and apply materials and manufacturing techniques
3. To introduce advanced technologies and enhance vehicle safety and aerodynamics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Vehicle Body Engineering: Classification of Coach Work type: Stylish Forms, Coach and Bus body style, layout of cars, buses and coach with different seating and loading capacity, Commercial vehicle types, Vans and Pickups Terms Used in Bus Body Building – Angle of Approach and Departure, Ground Clearance, Fender, Floor Longitudes, Post, Seat rails, Cant Rails, waist rails, roof sticks, Roof Longitude, Rub Rail, Skirt Rail, Wheel Arch Structure, Post Diagonals, Gussets, Industry standards and regulations that affect vehicle body design and construction	9
2	Vehicle Body materials –Aluminium Alloys, Steel, Alloy steels, Plastics, metal Matrix composites, Glass reinforced plastics and high strength composites, Thermoplastics, ABS, Load Bearing Plastics, semi rigid PUR Foams and Sandwich Panel Construction, Recycling of vehicle materials and sustainable practices in material selection and manufacturing. Paints and Adhesives – Paints, Adhesives and its properties, Corrosions, and their prevention	9
3	Vehicle Aerodynamics - Objectives, Vehicle drag and types, various types of forces and moments influencing drag, Effect of forces and moments, Side	9

	wind effects on force and moments, Introduction to CFD tools used in the design process for aerodynamic analysis. Various body optimization – Techniques for minimum drag, Wind Tunnels- Types and Principles, Flow Visualization techniques, Airflow Management System	
4	Vehicle Safety - Passive and Active vehicle Safety equipment's – Seat belt, Collapsible steering column, tilt able steering wheel, Air Bags, Electronic system for activating Air bag, Impact of emerging technologies such as electric vehicles (EVs) and Autonomous vehicles on vehicle body engineering.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand various vehicle body styles, including commercial types, and key building terms.	K2
CO2	Explore about materials and coatings used in vehicle bodies, including their properties and corrosion prevention methods.	K2
CO3	Optimize aerodynamic principles and techniques to reduce drag and enhance vehicle efficiency.	K2
CO4	Examine and evaluate passive and active safety features to improve occupant protection.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2	3	2								
CO4	3	2	3	2	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Principles of Automobile Body Design	Kingston Forbes	Creative Media Partners	2022
2	Vehicle Body Engineering	Giles J Pawlowski	Business books limited	1989
3	Body Engineering	Sydney F page	Chapman and Hall ltd, London	1956

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Wind Tunnel Testing	Jewel B. Barlow	John Wiley and Sons, 2 nd edition	1974
2	The Passenger Car body	SAE International		2000
3	Vehicle Body Layout and Analysis		Mechanical Engg, Publication Limited	2000

SEMESTER S7

TOTAL QUALITY MANAGEMENT

Course Code	PEAUT742	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. To equip students with foundational and advanced knowledge in Total Quality Management (TQM), including quality evaluation
2. To introduce students about leadership strategies, practical improvement tools, and advanced quality techniques for enhancing organizational performance.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Need for Quality – Evaluation of Quality – Definitions of Quality – Dimensions of product and service quality – Basic concepts of TQM – TQM frame work – Contributions of Deming, Juran, and Crosby – Barriers of TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints – Customer retention – Costs of Quality. International quality standards - ISO 9001, ISO/TS 16949, and their significance in the global market.	9
2	Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement PDCA cycle, 5S, Kaizen Supplier partnership - Partnering, Supplier selection, Supplier Rating. Change management in implementing TQM practices within an organization.	9
3	The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT-Bench marking -Reason to bench mark, Bench marking process	9

	– FMEA - Stages, Types, Integration of lean manufacturing principles with TQM, Fishbone Diagram (Ishikawa), Design of Experiments (DOE)	
4	Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function -TPM - Concepts, improvement needs - Performance measures. Case Studies related to TQM in the automotive industry, impact of Industry 4.0 and AI on quality management processes. Ethics in Quality Management.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the foundational concepts of Total Quality Management (TQM)	K2
CO2	Develop leadership and strategic planning skills in quality management, focusing on employee involvement, continuous improvement, and effective supplier partnerships.	K2
CO3	Apply traditional and modern quality management tools, including Six Sigma methodology, benchmarking, Failure Modes, and Effects Analysis (FMEA).	K3
CO4	Apply advanced quality techniques to enhance organizational performance and quality improvement.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2	3	2								
CO4	3	2	3	2	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Total Quality Management	N.V.R Naidu	G. Rajendra New Age international.	First Edition 2006
2	Total Quality Management	R.S Naagarazan	New Age international	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Total Quality Management	V.S Bagad	Technical Publications, First Edition	2008
2	Total Quality Management	S. Rajaram	Dreamtech Press, First Edition	2008
3	Quality Control & Application	Quality Control & Application	Prentice Hall of India,	2004

Video Links (NPTEL, SWAYAM...)
Link ID
Total Quality Management – I , Prof. Raghu Nandan Sengupta , IIT Kanpur , https://archive.nptel.ac.in/courses/110/104/110104080/
Total Quality Management – II , Prof. Raghu Nandan Sengupta , IIT Kanpur , https://archive.nptel.ac.in/courses/110/104/110104080/

SEMESTER S7

ADVANCED AUTOMOTIVE MANUFACTURING MATERIALS

Course Code	PEAUT745	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. To understand the fundamental properties of various materials used in automotive manufacturing, such as metals, polymers, composites, and ceramics.
2. To understand the latest advancements in automotive materials, including lightweight materials, high-strength alloys, and smart materials.
3. To understand the environmental impact of material selection and manufacturing processes in the automotive industry.
4. To Understand the emerging trends in automotive materials, including electric vehicle materials, light weighting for fuel efficiency, and advancements in battery technology

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Automotive Materials: Overview of material types: metals, polymers, composites, and ceramics. Criteria for material selection in the automotive industry. Metals in Automotive Applications; Ferrous and non-ferrous alloys. Properties Polymers and Composites, Thermoplastics, thermosetting plastics, and elastomers. Reinforced plastics, carbon fibre composites, and their automotive applications. Applications of steel, aluminium, magnesium, and titanium alloys. Ceramics and Glass. Structural ceramics, advanced ceramics, and their uses in engines and braking systems. Glass materials: properties and applications in automotive glazing.	9
2	Lightweight Materials: Importance of weight reduction in automotive design. Applications of advanced high-strength steels (AHSS), aluminium alloys, and magnesium alloys. High-Performance Materials, Superalloys, titanium alloys, and their applications in high-performance vehicles. Introduction to smart	9

	materials and shape memory alloys. Surface Engineering and Coatings Surface treatments, coatings for corrosion resistance, and wear protection. Role of coatings in improving material performance and longevity. Additive Manufacturing and Nanotechnology: Overview of additive manufacturing processes and their applications in the automotive industry. Nanomaterials: properties, synthesis, and applications.	
3	Environmental Considerations in Material Selection: Life cycle assessment (LCA) of automotive materials. Impact of materials on vehicle emissions and fuel efficiency. Strategies for recycling metals, polymers, and composites. End-of-life vehicle (ELV) recycling and circular economy concepts. Development and application of bio-based and biodegradable materials. Eco-design principles and their implementation in automotive manufacturing. Overview of environmental regulations affecting the automotive industry. Standards for automotive material sustainability and compliance.	9
4	Materials for Electric Vehicles (EVs): Requirements for light weighting and energy efficiency in EVs. Battery materials: lithium-ion, solid-state batteries, and future alternatives. Advanced Materials for Fuel Efficiency: Aerodynamics, lightweight materials, and their role in reducing fuel consumption, Use of composites and advanced alloys in structural components. Smart and Functional Materials: Development of self-healing materials, sensors, and conductive materials for automotive applications. Integration of smart materials in vehicle systems and components. Future Directions in Automotive Materials: Trends in material innovation, sustainability, and manufacturing processes. Research and development opportunities in new materials and technologies.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Assignment: 20 Marks

Students should evaluate and analyze a real-world optimization problem, assess the proposed solutions, provide a conclusion on which solution is most appropriate for the problem, and implement the chosen solution using any specific technique/tool/software/programme.

Criteria for evaluation:

1. Problem Definition (K4 - 4 points)

- a. Clearly defines the real-world optimization problem.
- b. Examine and identifies relevant contextual factors (constraints, resources, objectives).

2. Problem Analysis (K4 - 4 points)

- a. Break-down and presents a well-reasoned solution approach.
- b. Compare and justify the proposed solutions with evidence and logical reasoning.

3. Evaluate (K5 - 4 points)

- a. Thoroughly evaluate the proposed solutions.
- b. Compares trade-offs, advantages, and disadvantages.
- c. Considers feasibility, scalability, and practical implications.

4. Implementation (K5 - 4 points)

- a. Select the most feasible solution by implementing the proposed solutions/techniques.
- b. Successfully translates the problem to solution using proposed technique.
- c. Demonstrates proficiency in solution practices (readability, efficiency, error handling).

5. Conclusion (K4- 2 points, K5 – 2 points)

- a. Summarizes findings and insights. State which solution is most appropriate for the problem. (K4)
- b. Reflects critical thinking and informed decision-making. (K5)

Scoring:

1. **Accomplished (4 points):** Exceptional analysis, clear implementation, and depth of understanding.
2. **Competent (3 points):** Solid performance with minor areas for improvement.
3. **Developing (2 points):** Adequate effort but lacks depth or clarity.
4. **Minimal (1 point):** Incomplete or significantly flawed.

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental properties of various materials used in automotive manufacturing, such as metals, polymers, composites, and ceramics.	K2
CO2	Understand the latest advancements in automotive materials, including lightweight materials, high-strength alloys, and smart materials.	K2
CO3	Analyze the environmental impact of material selection and manufacturing processes in the automotive industry.	K4
CO4	Evaluate the emerging trends in automotive materials, including electric vehicle materials, light weighting for fuel efficiency, and advancements in battery technology.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	1	-	-	-	-	-	1
CO2	3	3	2	2	3	2	-	-	-	-	-	2
CO3	1	2	-	-	1	3	3	1	-	-	-	1
CO4	2	2	3	3	3	2	2	1	1	-	-	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Engineering: Lightweight, Functional, and Novel Materials	Brian Cantor, P. Grant, C. Johnston	CRC Press	2008
2	Automotive Materials Technology	James E. Duffy	Cengage Learning	2005
3	Materials for Automobile Bodies	Geoff Davies	Butterworth-Heinemann	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Materials in Automotive Engineering	Jason Rowe	Woodhead Publishing	2012
2	Sustainable Automotive Technologies	Jörg Wellnitz, Karsten Dröder, Bernhard Heinrich	Springer	2013
3	Handbook of Automotive Powertrain and Chassis Design	John Fenton	SAE International	2000
4	Materials for Sustainable Energy Applications: Conversion, Storage, Transmission, and Consumption	David Munoz-Rojas, Xavier Moya	CRC Press	2016
5	Automotive Engineering: Lightweight, Functional, and Novel Materials	Brian Cantor, Patrick Grant, Colin Johnston	CRC Press	2008

Video Link ID
Structure and analysis of nano materials by Prof. Kaushik Pal https://www.youtube.com/watch?v=vq8uFgTVIT0 Engineering Materials and Metallurgy"Dr. Vivek Pancholi, IIT Roorkee https://youtu.be/KWmWFs8ilQ4

SEMESTER S7

BLOCK CHAIN IN AUTOMOTIVE INDUSTRY

Course Code	PEAUT751	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. To introduce the fundamentals of blockchain technology and its relevance to the automotive industry.
2. To explore the potential applications of blockchain in various aspects of the automotive sector, including supply chain, manufacturing, and vehicle maintenance.
3. To equip students with the knowledge to analyze and implement blockchain solutions in automotive engineering contexts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of blockchain technology, how blockchain works: blocks, chains, nodes, and networks, Key concepts: decentralization, consensus mechanisms -Purpose of consensus in blockchain, Types of consensus mechanisms: (basic ideas only), Types of blockchains: public, private, and consortium, Overview of cryptocurrencies and their relation to blockchain	9
2	Use cases of blockchain in automotive supply chain management, Blockchain for vehicle manufacturing and assembly processes, Enhancing transparency and traceability in automotive logistics, Blockchain for quality assurance and compliance in automotive manufacturing, Case studies of blockchain implementation in leading automotive companies	9
3	Digital vehicle identities and smart contracts, Blockchain for vehicle registration and ownership transfer, Securing vehicle data and maintenance	9

	history with blockchain, Role of blockchain in vehicle insurance and claims processing, Practical applications, and case studies	
4	Emerging trends in blockchain technology and their potential impact on the automotive industry, Challenges in adopting blockchain in automotive applications, Regulatory and legal considerations, Integrating blockchain with other technologies: IoT, AI, and big data in autonomous vehicles. Prospects and career opportunities in blockchain for automotive engineers	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles and architecture of blockchain technology.	K2
CO2	Analyze the applications and benefits of blockchain in the automotive supply chain and manufacturing processes.	K4
CO3	Evaluate the use of blockchain for vehicle identity, ownership, and data security.	K5
CO4	Assess future trends and challenges of implementing blockchain in the automotive industry.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	-	-	-	-	-	-	-	-
CO2	-	3	2	3	-	-	-	-	-	-	-	-
CO3	-	-	3	-	3	-	-	-	-	-	-	-
CO4	2	3	2	3	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Blockchain Basics: A Non-Technical Introduction in 25 Steps	Daniel Drescher	Apress	1st Edition, 2017
2	Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World	Don Tapscott, Alex Tapscott	Penguin	1st Edition, 2016
3	Blockchain for Dummies	Tiana Laurence	Dummies	2nd Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Title: Blockchain Technology for IoT Applications	Seok-Won Lee, Arun Solanki, V. K. Singh	Academic Press	1st Edition, 2021
2	Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications , 2018	Imran Bashir	Packt Publishing	2nd Edition
3	Blockchain Enabled Applications: Understand the Blockchain Ecosystem and How to Make it Work for You	Vikram Dhillon, David Metcalf, Max Hooper	Apress	1st Edition, 2017

Video Links (NPTEL, SWAYAM...)	
	Link ID
	Blockchain Architecture Design and Use Cases , Prof. Sandip Chakraborty, IIT Kharagpur , https://onlinecourses.nptel.ac.in/noc19_cs63/preview
	Introduction to Blockchain Technology and Applications, Prof. Sandeep Shukla, IIT Kanpur, https://onlinecourses.nptel.ac.in/noc20_cs01/preview

SEMESTER S7

VEHICLE AERODYNAMICS

Course Code	PEAUT752	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. The course will impart knowledge of aerodynamic fundamentals and their effects on vehicle performance.
2. To introduce aerodynamic testing using wind tunnel testing, CFD, with the relative merits and limitations.
3. To enhance aerodynamic design for various vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Aerodynamics -Concept of Fluids, Basic Fluid Mechanics - Fluid properties related to aerodynamics, Forces in a fluid, Compressibility and incompressibility, Reynolds Number (Re), Mach number, Laminar and turbulent flow, hypersonic flows, Boundary Layer, Flow separation, Streamlines Streak lines and Path lines, Flow Visualization Techniques-types and application	9
2	Fundamentals of Aerodynamics - Resistances to vehicle motion. Aerodynamic drag, Effects of air resistance in vehicle performance and stability, pressure drag, Air flow wake, Relation between air resistance, frontal area, and vehicle velocity, drag co-efficient (simple problems related to the relations), Idea of drag co-efficient of various shapes.	9
3	Aerodynamic lift and Downforce -Vehicle Handling-The origin of force and moments on a vehicle, Effects of forces and moments, Side wind problems, Vehicle dynamics Under side winds, Car body drag reduction, wind noise, Aerodynamic lift control- Aerodynamic aids, after body drag- square back	9

	drag, fast back drag, notch back drag, hatch back drag. Effect of down force on vehicle performance, Vortices	
4	Aerodynamic Testing- Wind Tunnels for Automotive, Principles of wind tunnel technology, Types, and components of wind tunnel. Limitation of simulation – Stress with scale models – Full scale wind tunnels – Measurement techniques – Equipment and transducers – Road testing methods, numerical methods-CFD. Aerodynamic study of F1 Racing cars, Sports car, SUVs.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand fluid mechanics, Reynolds number, boundary layers, and flow visualization	K2
CO2	Analyze aerodynamic drag, air resistance, drag coefficient, and their effects on vehicle performance	K3
CO3	Understand aerodynamic lift, downforce, side winds, drag types, and their impact on vehicle performance.	K2
CO4	Comprehensive understanding aerodynamic testing techniques, wind tunnels, CFD, and road-testing methods	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1								1
CO2	3	3		1								1
CO3	3	1	2				1					1
CO4	3	1		2	3				2	2		2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aerodynamics for Engineers	John J Bertin	PEARSON	4 th , 2013
2	Automotive Aerodynamics	Joseph Katz	WILEY	2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aerodynamics of Road Vehicles	Thomas Christian Schuetz	SAE International	5 th , 2015
2	Aerodynamics of Road Vehicles	Wolf-Heinrich Hucho	SAE International	1998
3	Aerodynamics for Engineering Students	E.L. Houghton, P.W. Carpenter, Steven H. Collicott, Daniel T. Valentine	BH	5 th , 2013

SEMESTER S7

SUPPLY CHAIN MANAGEMENT

Course Code	PEAUT753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with a comprehensive understanding of supply chain management principles and their strategic importance in the automotive industry.
2. To equip students with the skills to plan, forecast, and optimize supply chain operations, focusing on inventory management, production planning, and transportation.
3. To enable students to apply collaborative strategies and emerging technologies to enhance supply chain integration and address challenges in a globalized environment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Supply Chain Management Overview of Supply Chain Management (SCM): Definition, importance, and key components of SCM in the automotive industry. Supply Chain Concepts and Terminology: Understanding the supply chain, logistics, value chain, and their interrelations. Automotive Supply Chain Structure: Components of the automotive supply chain, including suppliers, manufacturers, distributors, retailers, and customers. Supply Chain Models and Frameworks: Overview of common supply chain models, such as the SCOR model, and their application in the automotive industry. Role of SCM in the Automotive Industry: The strategic importance of SCM in reducing costs, improving efficiency, and enhancing customer satisfaction in the automotive sector.	9
2	Supply Chain Planning and Strategy Strategic Supply Chain Planning: Long-term planning and decision-making in supply chain management to align with business goals. Demand Forecasting and Planning: Techniques for predicting customer demand and aligning	9

	production schedules accordingly. Inventory Management: Principles of inventory control, optimization strategies, and their importance in the automotive supply chain. Production Planning and Control: Integration of production schedules with supply chain processes to ensure smooth operations. Transportation and Distribution Planning: Planning and optimizing the movement of goods from suppliers to customers, focusing on efficiency and cost-effectiveness.	
3	Supply Chain Integration and Collaboration Supply Chain Integration: Strategies for achieving seamless integration of internal and external supply chain processes. Role of Information Technology in SCM: How IT systems and tools like ERP, SCM software, and IoT are used to enhance supply chain visibility and efficiency. Collaborative Planning, Forecasting, and Replenishment (CPFR): Framework for collaboration between supply chain partners to improve demand planning and inventory management. Vendor-Managed Inventory (VMI): Understanding VMI systems and their benefits in reducing inventory levels and improving supplier relationships. Case Studies in Supply Chain Collaboration: Analysis of successful collaboration practices in the automotive industry and lessons learned.	9
4	Emerging Trends and Challenges in Supply Chain Management Globalization and Its Impact on Supply Chains: Understanding the effects of globalization on supply chain complexity, risk, and management practices. Sustainable Supply Chain Management: Strategies for implementing environmentally sustainable practices in the automotive supply chain. Risk Management in Supply Chains: Identifying and mitigating risks in the supply chain, including geopolitical risks, natural disasters, and supply disruptions. Agile supply chains, and the move towards a circular economy. Technological Innovations in SCM: Exploring the impact of emerging technologies; AI, blockchain, and big data analytics on supply chain management.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the key components of a supply chain and their roles in the overall supply chain management process	K2
CO2	Understand the various techniques used in demand forecasting, inventory management, and production planning within the context of supply chain strategy.	K2
CO3	Apply collaborative planning and vendor-managed inventory strategies to improve supply chain efficiency	K3
CO4	Analyze the impact of emerging technologies and global trends on supply chain management practices, and propose solutions to address related challenges.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2									
CO2		2			2							
CO3				2		3						
CO4			3							2		
CO5												

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Supply Chain Management: Strategy, Planning, and Operation	Sunil Chopra and Peter Meindl	Pearson Edition	6th Edition, 2019
2	Logistics and Supply Chain Management	John J. Coyle, C. John Langley, Robert A. Novack, and Brian J. Gibson	Cengage Learning	6th Edition, 2016
3	Principles of Supply Chain Management: A Balanced Approach	Robert B. Handfield and Ernest L. Nichols Jr.	Cengage Learning	3rd Edition, 2016
4	Supply Chain Management: A Managerial Approach	K. C. Shekhar and G. S. Gupta	PHI Learning	1st Edition, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Supply Chain Management: Text and Cases	K. Rajesh	Oxford University Press	1st Edition, 2018
2	Managing Supply Chains: A Logistics Approach	John T. Mentzer, Matthew B. Myers, and Theodore P. Stank	Sage Publications	1st Edition, 2007

Video Links (NPTEL, SWAYAM...)	
	Link ID
1	Logistics & Supply Chain Management , By Prof. Vikas Thakur IIT Kharagpur , https://onlinecourses.nptel.ac.in/noc24_hs128/preview
2	Operations And Supply Chain Management , By Prof. G. Srinivasan IIT Madras , https://onlinecourses.nptel.ac.in/noc23_mg71/preview

SEMESTER S7

NOISE, VIBRATION AND HARSHNESS

Course Code	PEAUT755	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. To impart fundamental knowledge of acoustics and vibration principles and their relevance in the automotive industry.
2. To enable students to understand and analyse the sources and control methods of noise and vibrations in vehicles.
3. To familiarize students with the psychological effects of noise and vibration and the standards and legislations related to NVH in the automotive field.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Acoustics – General types of sound wave propagation, linearized wave equation, Acoustic velocity potential, Propagation of sound waves, sound intensity, energy density, sound power, Inhomogeneous wave equation, Lighthill's analogy, effect of the presence of solid bodies in the flow. The Powell Howe theory of vortex sound. Acoustic source models, monopoles, dipoles, quadrupole.	9
2	Fundamental of Vibration- Basic concept of vibration, Damped and un damped vibration, Free and forced vibration, Analysis of single degree freedom system and two-degree freedom system. Modes of vibration, Resonance, Transmissivity, Vibration isolation.	9
3	Vibration Measurement and Control- Sources of vibration, Vibration pickups, Transducers, Accelerometers, Different types of dampers, Viscous damping, sand-witch construction, Vibration absorbers and isolators. Noise Measurement and Control- Sources of noise, Noise measuring instruments, microphones, sound intensity probes, Noise control methods,	9

	active and semi active control of noise, anechoic chamber, isolators and noise absorbing materials.	
4	Harshness- Definition, psychological effect of noise and vibration, sound quality matrix, loudness, roughness, sharpness, fluctuation strength, psychoacoustic indexes, acceptable degree of harshness, Sound quality indexes for high frequency tonal noise, Application of sound quality indexes in NVH analysis, Study of NVH legislations applicable for vehicles in India, Introduction to software applications for NVH analysis.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Assignment: 20 Marks

Students should evaluate and analyze a real-world optimization problem, assess the proposed solutions, provide a conclusion on which solution is most appropriate for the problem, and implement the chosen solution using any specific technique/tool/software/programme.

Criteria for evaluation:

6. Problem Definition (K4 - 4 points)

- a. Clearly defines the real-world optimization problem.
- b. Examine and identifies relevant contextual factors (constraints, resources, objectives).

7. Problem Analysis (K4 - 4 points)

- a. Break-down and presents a well-reasoned solution approach.
- b. Compare and justify the proposed solutions with evidence and logical reasoning.

8. Evaluate (K5 - 4 points)

- a. Thoroughly evaluate the proposed solutions.
- b. Compares trade-offs, advantages, and disadvantages.
- c. Considers feasibility, scalability, and practical implications.

9. Implementation (K5 - 4 points)

- a. Select the most feasible solution by implementing the proposed solutions/techniques.
- b. Successfully translates the problem to solution using proposed technique.
- c. Demonstrates proficiency in solution practices (readability, efficiency, error handling).

10. Conclusion (K4- 2 points, K5 – 2 points)

- a. Summarizes findings and insights. State which solution is most appropriate for the problem.
(K4)
- b. Reflects critical thinking and informed decision-making. (K5)

Scoring:

5. **Accomplished (4 points):** Exceptional analysis, clear implementation, and depth of understanding.
6. **Competent (3 points):** Solid performance with minor areas for improvement.
7. **Developing (2 points):** Adequate effort but lacks depth or clarity.
8. **Minimal (1 point):** Incomplete or significantly flawed.

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the fundamentals of acoustics, including sound wave propagation, sound intensity, and the effect of solid bodies in the flow	K2
CO2	Apply the fundamental concepts of vibration, including damped and undamped vibrations, resonance, and vibration isolation techniques	K3
CO3	Analyse methods for vibration measurement and control, and understand noise measurement techniques and control methods	K4
CO4	Evaluate the psychological effects of noise and vibration, apply sound quality indices in NVH analysis, and understand the relevant NVH legislations in India	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	-	-	-	-	-	-	2
CO2	3	2	2	2	2	-	-	-	-	-	-	2
CO3	3	3	2	2	2	1	-	-	-	-	1	2
CO4	3	3	2	3	3	1	1	1	-	1	2	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Noise and Vibration Control	L. L. Beranek	McGraw-Hill	2nd Edition, 2008
2	Engineering Noise Control: Theory and Practice	David A. Bies, Colin H. Hansen	CRC Press	4th Edition, 2009
3	Theory of Vibration with Applications	William T. Thomson, Marie Dillon Dahleh	Prentice Hall	5th Edition, 1997
4	Mechanical Vibrations	S. S. Rao	Pearson	5th Edition, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Vibration and Sound	Thomas D. Rossing, Neville H. Fletcher	Springer	2nd Edition, 2004
2	Vibration and Acoustics: Measurement and Signal Analysis	C. Sujatha	McGraw-Hill Education	2010
3	Noise Control: From Concept to Application	Colin H. Hansen	CRC Press	1st Edition, 2005
4	Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles	Matthew Harrison	Elsevier	1st Edition, 2004

Video Links (NPTEL, SWAYAM...)	
	Link ID
1	NPTEL - Noise Management and Control , Prof. S. P. Harsha , Indian Institute of Technology Roorkee (IIT Roorkee) https://onlinecourses.nptel.ac.in/noc22_me52/preview

SEMESTER S7

ELECTRIC AND HYBRID VEHICLE

Course Code	OEMUT721	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. Understand the fundamental principles and components of Electric and Hybrid vehicle technologies, including their energy conversion mechanisms and powertrain configurations.
2. Understand the environmental and societal impacts of Electric and Hybrid vehicles, comparing their advantages and challenges with conventional internal combustion engine vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Electric vehicles: Past, Present & Future of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives EV Parameters: Weight, size, force, energy & performance parameters.	9
2	Introduction to hybrid vehicles: Need for hybrid and electric vehicles, components, advantages and disadvantages, application, social and environmental impacts. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies (Series, Parallel, Series – Parallel), power flow control in hybrid drive-train topologies	9
3	Electric Machines and their controllers: ‘Brushed’ DC Electric Motor - DC regulation and voltage conversion; Brushless Electric Motors - Brushless DC motor, Switched reluctance motors, Induction motor; Motor cooling, efficiency, size and mass. Thermal Management of HEV Power	9

	Electronics Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE)	
4	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Ultra capacitors, Flywheel based energy storage and its analysis, Flywheel Accumulators, Superconducting magnetic energy storage; Hydraulic Accumulators; Hydraulic Pumps/Motors - Pneumatic Hybrid Engine Systems. Energy management strategies used in hybrid and electric vehicles: types, comparison and implementation issues Hybridization of different energy storage devices, Fuel Cell technology.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental need for electric vehicles, their components, advantages and disadvantages, applications, and the comparison with IC Engine Vehicles.	K2
CO2	Understand the fundamental need for hybrid and electric vehicles, their components, advantages and disadvantages, applications, and the social and environmental impacts associated with their use.	K2
CO3	Apply various types of electric machines, their controllers, and thermal management strategies in hybrid electric vehicles, emphasizing efficiency, performance, and integration with internal combustion engines.	K3
CO4	Apply various energy storage technologies used in hybrid and electric vehicles, their characteristics, integration challenges, and energy management strategies for optimal performance.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2							
CO2	3	3	3	3	2							
CO3	2	2	2	3	3							
CO4	2	2	2	3	3							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Kambiz Ebrahimi, Mehrdad Ehsani, Stefano Longo, Yimin Gao	CRC Press	2018
2	Electric and hybrid vehicles	A.K. Babu	Khanna publishers	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hybrid, Electric and Fuel-Cell Vehicles, International Edition	<u>Erjavec Jack</u>	Cengage Learning, Inc	2018
2	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Ehsani Mehrdad	Taylor & Francis Inc	2019

Video Links	
	Link ID
	Fundamentals of Electric vehicles: Technology & Economics, IIT Madras- Prof. Ashok Jhunjhunwala Prof. Prabhjot Kaur Prof. Kaushal Kumar Jha Prof. L Kannan - https://nptel.ac.in/courses/108106170 Fuel Cell Technology, IIT Delhi , Prof. S. Basu , Dr. Anil Verma - https://nptel.ac.in/courses/103102015

SEMESTER S7

AUTOMOTIVE ERGONOMICS AND SAFETY

Course Code	OEMUT722	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. To gain knowledge of human anatomy and anthropometric data, focusing on how these factors influence vehicle design to accommodate diverse populations.
2. To apply ergonomic principles to improve comfort and safety in automotive design, considering the physical and psychological needs of drivers and passengers.
3. To explore the use of ergonomic data and standards to optimize the design of advanced driving systems, ensuring accessibility and usability for a wide range of users.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to ergonomics: Definition and importance of ergonomics, History, and evolution of ergonomics in automotive design, Human anatomy and biomechanics, Human capabilities and limitations, Interaction between driver, vehicle, and environment. Anthropometry and Ergonomics - Body measurements and vehicle accommodation, Design for diverse populations (age, gender, size), Ergonomic considerations for special needs, Applying anthropometry data, Design guidelines and standards (ISO, SAE)	9
2	Driver and Passenger Comfort - Seating Comfort, Seat design and adjustments, Cushion materials and support, Pressure distribution and fatigue reduction, Climate Control and Acoustics, HVAC systems and airflow, Noise, vibration, and harshness (NVH) control, Acoustic materials and insulation, Interior Layout and Space Utilization, Cabin space optimization, Storage and accessibility, Ergonomic layout of the cockpit	9

3	Safety and Ergonomics- Introduction to safety: Design of the body for safety, energy equation, engine location, concept of crumple zone. Active and Passive Safety Systems, Seat belts and airbag systems, Ergonomics of dashboard and instrument panel, Emergency controls and their accessibility. Ergonomics in Advanced Driver Assistance Systems (ADAS), User-friendly interfaces for ADAS, Haptic feedback and tactile controls.	9
4	Ergonomics in Crash Safety-Crash test dummies and ergonomic data, Vehicle interior design for impact protection, Innovations in Automotive Ergonomics- Ergonomic simulation software and tools, Ergonomic challenges in autonomous vehicles, Redesigning vehicle interiors for autonomous driving, Ergonomics in electric and hybrid vehicles.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand ergonomics in automotive design, focusing on human factors and standards.	K2
CO2	Understand and optimize driver and passenger comfort and interior ergonomics.	K2
CO3	Understand safety systems, ADAS ergonomics, and their impact on vehicle design.	K2
CO4	Impart understanding of automotive ergonomics and its application in safety design.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2		1	1						1
CO2	3		3	2			1					1
CO3	3	2	3					2				2
CO4	3			3	3						1	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Ergonomics: Driver-Vehicle Interaction	Michael S. Lewis	CRC Press	2022
2	Human Factors in Automotive Engineering and Design	Guy H. Walker	CRC Press	2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Safety: The Science of Vehicle Safety	John W. Smith	Wiley	2019
2	Introduction to Automotive Engineering	M. A. D. T. Schuetz	SAE International	2021
3	Human Factors and Ergonomics in Automotive Design	A. M. Prasad	Springer India	2022
4	Introduction to Ergonomics	Robert Bridger	C RC Press	2020

Video Links	
	Link ID
1	Ergonomics In Automotive Design , By Prof. Sougata Karmakar IIT Guwahati https://onlinecourses.nptel.ac.in/noc19_de01/preview
2	Human Factors Engineering , By Prof. Pradip Kumar Ray, Prof. V. K. Tewari IIT Kharagpur - https://onlinecourses.nptel.ac.in/noc24_mg108/preview

SEMESTER S7

VEHICLE AERODYNAMICS

Course Code	OEAUT723	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. To learn the key principles of aerodynamics, including drag, lift, and down force, and how these forces influence vehicle performance.
2. To gain knowledge of wind tunnel testing and computational fluid dynamics (CFD), including their applications and limitations in aerodynamic analysis.
3. To apply aerodynamic principles and testing techniques to optimize the design and performance of various types of vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Aerodynamics-Concept of Fluids, Basic Fluid Mechanics- Fluid properties related to aerodynamics, Forces in a fluid, Compressibility and incompressibility, Reynolds Number (Re), Mach number, Laminar and turbulent flow, hypersonic flows Boundary Layer, Flow separation, Streamlines Streak lines and Path lines, Flow Visualization Techniques-types and application	9
2	Fundamentals of Aerodynamics- Resistances to vehicle motion. Aerodynamic drag, Effects of air resistance in vehicle performance and stability, pressure drag, Air flow wake, Relation between air resistance, frontal area and vehicle velocity, drag co-efficient (simple problems related to the relations), Idea of drag co-efficient of various shapes.	9
3	Aerodynamic lift and Downforce -Vehicle Handling-The origin of force and moments on a vehicle, Effects of forces and moments, Side wind problems, Vehicle dynamics Under side winds, Car body drag	9

	reduction, wind noise, Aerodynamic lift control- Aerodynamic aids, after body drag- square back drag, fast back drag, notch back drag, hatch back drag. Effect of down force on vehicle performance, Vortices	
4	Aerodynamic Testing- Wind Tunnels for Automotive, Principles of wind tunnel technology, Types and components of wind tunnel. Limitation of simulation – Stress with scale models – Full scale wind tunnels – Measurement techniques – Equipment and transducers – Road testing methods, numerical methods-CFD. Aerodynamic study of F1 Racing cars, Sports car, SUVs.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand fluid mechanics, Reynolds number, boundary layers, and flow visualization	K2
CO2	Analyze aerodynamic drag, air resistance, drag coefficient, and their effects on vehicle performance	K3
CO3	Understand aerodynamic lift, downforce, side winds, drag types, and their impact on vehicle performance.	K2
CO4	Comprehensive understanding of aerodynamic testing techniques, wind tunnels, CFD, and road-testing methods	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1								1
CO2	3	3		1								1
CO3	3	1	2				1					1
CO4	3	1		2	3				2	2		2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aerodynamics for Engineers	John J Bertin	PEARSON	4 th , 2013
2	Automotive Aerodynamics	Joseph Katz	WILEY	2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aerodynamics of Road Vehicles	Thomas Christian Schuetz	SAE International	5 th , 2015
2	Aerodynamics of Road Vehicles	Wolf-Heinrich Hucho	SAE International	1998
3	Aerodynamics for Engineering Students	E.L. Houghton, P.W. Carpenter, Steven H. Collicott, Daniel T. Valentine	BH	5 th , 2013

SEMESTER 8

AUTOMOBILE ENGINEERING

SEMESTER S8

AUTOMOTIVE COMFORT AND SAFETY ENGINEERING

Course Code	PEAUT861	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart the basic concepts of automotive ergonomics and automotive safety
2. To impart the basic concepts of creating workspace for driver

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Ergonomics in vehicle design – system approach – research studies – engineer's role – importance and implementing ergonomics. Anthropometry – Use of anthropometry – calculation of percentile value. Application of biomechanics in vehicle design – seat design. Entrance and Exit from automobiles – problems during entrance and exit – features and dimensions – door handles, lateral sections, body opening clearance, hinge angles, seat bolsters, location and material.	9
2	Driver performance measurement – driving and non-driving tasks. Performance measures – types and category – range – studies – deviation from lateral position, steering wheel angle, velocity, task time, glance duration – application. Driver workload measurement – present situation – methods to measure – studies.	9
3	Vehicle evaluation – methods of data collection and analysis – subjective methods – rating on a scale, paired comparison, thurstone method.	9

	Application of evaluation techniques – checklists, observational studies, user interviews, driving simulator studies, field studies. Understanding users – issues and considerations – vehicle types, market segments, female and old drivers, geographic locations. Issue in designing global vehicles.	
4	Automotive safety – passive and active safety – seatbelt-three point seatbelts – Airbags – types and operation – crumple zones – materials – passenger cage – materials Crash testing – Ergonomic dummies-types, components and materials used, application, human testing – crash worthiness – deceleration curves, square wave, injury tolerance, control of deceleration, pole testing, roll over testing. Compliance testing, component testing, in-field testing, safety ratings.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles and importance of ergonomics in vehicle design.	K2
CO2	Apply methods for measuring and analyzing driver performance and workload.	K3
CO3	Analyze vehicle evaluation techniques and understand user needs across different vehicle types and market segments.	K4
CO4	Acquire knowledge about automotive safety systems, crash testing methods, and the design of safety features to improve vehicle crashworthiness and occupant protection.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									
CO2	2	2	2						2			
CO3	2	2	3								2	
CO4	2	2	3									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Human Factors in Automotive Engineering and Technology.	Guy H. Walker, Neville A. Stanton	CRC Press	2014
2	Automotive Ergonomics: Driver-Vehicle Interaction	Nikolaos Gkikas	WileyCRC Press	2017
3	The Science of Vehicle Dynamics: Handling, Braking, and Ride of Road and Race Cars	Massimo Guiggiani	Springer	2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ergonomics in Design: Methods and Techniques	Marcelo M. Soares.	CRC Press	2016
2	Vehicle Crash Mechanics	Matthew Huang	CRC Press	2002

SEMESTER S8

ADVANCED AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS

Course Code	PEAUT862	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the working of vehicle networks and their architecture
2. To understand how engines are controlled digitally and the working of advanced driver assist systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Vehicle Networks and software: Vehicle network systems – Introduction; Network Architecture – Types; Network communication; Vehicle Networks – CAN, LIN, MOST, Flex Ray Protocol; Vehicle Network Diagnosis; Real time operating systems (RTOS) – Introduction; AUTOSAR – Introduction, System architecture, Software architecture.	9
2	Automotive Communication Systems: Ethernet in Automobiles. Connected car – Cyber – Physical systems; Wireless sensor networks; Telematics; Vehicle to network (V2N), Vehicle to infrastructure (V2I), Vehicle to vehicle (V2V), Vehicle to cloud (V2C), Vehicle to pedestrian (V2P), Vehicle to device (V2D), Vehicle to grid (V2G). In Vehicle networks: Types of IVNs- Body, Powertrain, Chassis, and Infotainment networks	9
3	Digital engine control systems: Electronic fuel control, engine control sequence, open loop and closed control, cold starting, acceleration and full load; enrichment, deceleration leaning, overrun fuel cut off, Idle speed control	9

	and EGR control; Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced post injection and retarded post injection. Electronic ignition control, Ignition timing map, Ignition timing calculation (Initial timing, Basic advance angle, Corrective advance angle), spark advance correction scheme.	
4	Advanced Driver Assistance Systems: Adaptive Cruise control system, Anti-lock braking system, Traction control system, electronic brake force distribution, electronic stability program, Airbags, Collision avoidance radar warning system, Tyre pressure monitoring, Lane departure warning system, Night vision system. Electronic control transmission: control of shift timing, control of lock up, neutral to drive squat control, engine torque control. Dual clutch automatic, Automated manual transmission, continuously variable transmission. GPS navigation.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand vehicle network concepts, protocols, and diagnostic practices and AUTOSAR principles with their role in modern automotive software development.	K2
CO2	Understand automotive communication systems, their applications, and their role in shaping the future of mobility.	K2
CO3	Understand the working of electronic fuel control systems and their response to various operating conditions, various system parameters affect combustion, noise, and emissions in CI engines.	K2
CO4	Analyse how electronic control of automatic transmission takes place and how various advance driver assist systems work.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									
CO2	3	3	3									
CO3	2	2	2									
CO4	2	2	2									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Understanding Automotive Electronics: An Engineering Perspective	William B Ribbens	Butterworth-Heinemann	7 th , 2012
2	Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair	Tom Denton	Cengage Learning India	September , 2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Automotive Electricity and Electronics	Michael Klyde, Kirk Van Gelder	Jones & Bartlett Learning	2018
2	Automotive Embedded Systems	Nicolas Navet, Francoise Simonot - Lion	CRC Press	2009
3	A Handbook of Driver Assistance Systems	Hermann Winner, Stephan Hakuli, Felix Lotz, Christina Singer	Springer Reference	2016
4	Guide to Automotive Connectivity and Cybersecurity - Trends, Technologies, Innovations and Applications	Dietmar P. F. Möller, Roland E. Haas	Springer	2019

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
	Automotive Electrics and Automotive Electronics – udemy - https://www.udemy.com/course/automotive-electrics-and-automotive-electronics Automotive Electronics – Future Technology Trends - https://www.youtube.com/watch?v=BOP8qLQzhDc

SEMESTER S8

ADVANCED VEHICLE TECHNOLOGY

Course Code	PEAUT865	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand and apply various Artificial Intelligence techniques in automotive systems, including machine learning, deep learning, and reinforcement learning, to enhance vehicle functionalities such as traffic sign recognition, driver assistance, and structural design improvements.
2. To explore the integration of AI and machine learning in electric vehicles for optimizing battery management, energy usage, and powertrain efficiency, as well as for enhancing regenerative braking systems and charging infrastructure.
3. To evaluate and implement AI-driven solutions in autonomous vehicles and vehicle maintenance, including predictive maintenance.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Artificial Intelligence in Automotive Applications Types of AI Used in Vehicles: Machine Learning, Deep Learning. Benefits, Challenges and Ethical Considerations Machine Learning Algorithms for Automotive Systems - Supervised Learning- Algorithms: Regression, Classification, Neural Networks, and Applications in Vehicle Systems: Traffic Sign Recognition, Driver Assistance. Unsupervised Learning - Algorithms: Clustering, Dimensionality Reduction, Applications: Anomaly Detection,	9

	Feature Extraction. Reinforcement Learning - Principles of Reinforcement Learning Using AI for Structural and Aesthetic Design Improvements, AI-Driven Simulation Techniques for Performance Evaluation Robotics and Automation Enhanced by AI.	
2	AI and ML in Electric Vehicles AI for Battery Management: Battery Health Monitoring: Using AI to Track Battery Performance and Predict Failures. Energy Management: AI Techniques for Optimizing Battery Usage and Charging. AI in EV Powertrain Optimization: Motor Control: AI for Enhancing Electric Motor Efficiency and Performance. Regenerative Braking: AI for Maximizing Energy Recovery. Charging Infrastructure and Optimization: Smart Charging Systems: AI for Efficient Charging Scheduling and Load Management. Charging Network Optimization: AI for Planning and Managing EV Charging Stations. Examples of AI Implementations.	9
3	Autonomous Vehicles Introduction to Autonomous Vehicles, Definition and Levels of Automation, Overview of Automation Levels (SAE Levels 0-5), Key Components and working principles. Data Processing and Decision Making, Software and Hardware Architecture, Safety and Cyber security Considerations, Leading Companies, and their Innovations	9
4	AI in Vehicle Maintenance and Diagnostics Predictive Maintenance - AI Techniques for Predicting Failures: Using Data Analytics to Forecast Vehicle Maintenance Needs. Condition-Based Monitoring: AI for Monitoring Vehicle Health in Real-Time. AI for Diagnostic Systems - Onboard Diagnostics: AI-Enhanced Diagnostics for Identifying and Resolving Issues. Remote Diagnostics: Using AI for Diagnosing Problems from a Distance. AI in Repair and Service - Automated Service Recommendations: AI for Providing Maintenance and Repair Suggestions, Service Automation: AI in Automating Diagnostic and Repair Processes. Examples of AI-Driven Maintenance and Diagnostics	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Internal Ex	Evaluate	Analyse	Total
5	15	10	10	40

Assignment: 20 Marks

Students should evaluate and analyze a real-world optimization problem, assess the proposed solutions, provide a conclusion on which solution is most appropriate for the problem, and implement the chosen solution using any specific technique/tool/software/programme.

Criteria for evaluation:

1. Problem Definition (K4 - 4 points)

- a. Clearly defines the real-world optimization problem.
- b. Examine and identifies relevant contextual factors (constraints, resources, objectives).

2. Problem Analysis (K4 - 4 points)

- a. Break-down and presents a well-reasoned solution approach.
- b. Compare and justify the proposed solutions with evidence and logical reasoning.

3. Evaluate (K5 - 4 points)

- a. Thoroughly evaluate the proposed solutions.
- b. Compares trade-offs, advantages, and disadvantages.
- c. Considers feasibility, scalability, and practical implications.

4. Implementation (K5 - 4 points)

- a. Select the most feasible solution by implementing the proposed solutions/techniques.
- b. Successfully translates the problem to solution using proposed technique.
- c. Demonstrates proficiency in solution practices (readability, efficiency, error handling).

5. Conclusion (K4- 2 points, K5 – 2 points)

- a. Summarizes findings and insights. State which solution is most appropriate for the problem. **(K4)**
- b. Reflects critical thinking and informed decision-making. **(K5)**

Scoring:

1. **Accomplished (4 points):** Exceptional analysis, clear implementation, and depth of understanding.
2. **Competent (3 points):** Solid performance with minor areas for improvement.
3. **Developing (2 points):** Adequate effort but lacks depth or clarity.
4. **Minimal (1 point):** Incomplete or significantly flawed.

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the various types of AI, including machine learning, deep learning, and reinforcement learning, and their applications in automotive systems	K2
CO2	Apply AI techniques to optimize battery management and powertrain performance in electric vehicles, including energy management and regenerative braking systems.	K3
CO3	Analyse the software and hardware architecture of autonomous vehicles, evaluating how data processing and decision-making frameworks contribute to various levels of automation and addressing safety and cyber security considerations.	K4
CO4	Understand AI-driven diagnostic systems and their applications in vehicle maintenance, including on board diagnostics and remote diagnostic techniques.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	3	-	-					
CO2	3	3	3	3	3	-	-					
CO3	3	2	3	2	3	-	-					
CO4	2	2	2	2	2	3	3					

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence for Autonomous Vehicles	Rajeev Agrawal	Springer	1st Edition, 2022
2	Machine Learning for Vehicle Systems: From Concept to Application	Ehsan Elahi	Wiley	1st Edition, 2023
3	Artificial Intelligence in Electric Vehicles	Tarek S. Sobh	CRC Press	1st Edition, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Artificial Intelligence in Transportation Systems: Design, Analysis, and Optimization	Shuo Wang and David M. Rodriguez	Springer	1st Edition, 2022
2	Autonomous Vehicles: Opportunities, Strategies, and Disruptions.	Steven E. Shladover	Elsevier	2014
3	Autonomous Vehicles: Opportunities, Strategies, and Threats	K. W. Lee, S. S. Kim, and J. H. Park	Academic Press	1st Edition, 2020
4	Automotive Safety: Anatomy, Injury, Testing, and Regulation	Jeffrey A. Pike and Matthew Reed	SAE International	2020

Video Links	
	Link ID
	Fundamentals of Electric vehicles: Technology & Economics By Prof. Ashok Jhunjhunwala, Prof. Kaushal Jha, Prof. L Kannan, Prof. Prabhjot Kaur IIT Madras: - https://onlinecourses.nptel.ac.in/noc20_ee99/preview Introduction to Machine Learning, By Prof. Sudeshna Sarkar IIT Kharagpur: - https://onlinecourses.nptel.ac.in/noc22_cs97/preview

SEMESTER S8

VEHICLE PERFORMANCE AND TESTING

Course Code	OEAUT831	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand engine and vehicle testing methods, focusing on performance, energy, and fuel consumption.
2. To understand crashworthiness and perform comprehensive impact tests using advanced crash test techniques.
3. To analyse aerodynamic analysis and control vehicle noise and vibration through wind tunnel testing and NVH techniques.
4. To analyse ride quality and safety using vibration measurement and comprehensive wheel and brake performance tests.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Engine and Vehicle Testing : Basic engine parameters- Measurement of BHP and IHP- Engine testing on dynamometers (hydraulic, eddy current, etc.)- Vehicle testing on chassis dynamometers (two-wheel and four-wheel)- Vehicle testing lanes (side slip testers, brake testers, headlight alignment testing)- Engine analysers for petrol and diesel engines- Exhaust gas analysers (Orsat apparatus, infrared gas analysers, smoke meter)- Energy consumption tests (engine cooling fan, air conditioning, brake compressors)- Fuel consumption tests, test route selection, vehicle test speeds	9

2	Collision and Crash Testing: Human testing, dummies- Crashworthiness- Pole crash testing, near crash testing- Vehicle-to-vehicle impact, side impact testing- Crash test sensors, sensor mounting positions- Crash test data acquisition- Braking distance test	9
3	Wind Tunnel Testing and Noise, Vibration and Harshness (NVH) : Wind tunnel test requirements- Ground boundary simulation- Wind tunnel selection and Reynolds number capability- Model requirements, details, and mounting- Test procedure- Automotive noise criteria- Standard noise measurement methods- Noise inside and outside the vehicle- Sources of vehicle noise (intake and exhaust noise, combustion noise, mechanical noise, noise from auxiliaries, wind noise, transmission noise, brake squeal, structure noise)- Noise control methods	9
4	Ride Vibration, Body Testing, Wheels, and Braking Performance: Vibration measurement instruments (accelerometer and signal conditioning)- Dynamic cornering fatigue and dynamic radial fatigue tests (procedure)- Impact test (road hazard impact test for wheel and tyre assemblies, test procedures, failure criteria, performance criteria)- Bumpers (types of tests, pendulum test, fixed collision barrier test procedure, performance criteria)- Air	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and measure engine performance, vehicle testing on dynamometers, and evaluate energy and fuel consumption in various conditions	K2
CO2	Analyse crashworthiness, conduct impact tests using dummies and sensors, and interpret crash test data for vehicle safety improvements	K4
CO3	Understand wind tunnel tests for aerodynamic analysis, measure and control vehicle noise and vibration, and apply NVH reduction techniques.	K2
CO4	Analyse ride quality using vibration measurement, perform wheel and braking performance tests, and evaluate safety through impact and brake testing.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2							
CO2	3	3	2	-	2							
CO3	3	2	1	2	2							
CO4	3	3	2	-	2							

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Mechanics	Crouse W.H. and Anglin D.L.	Tata McGraw-Hill Publishing Co.	1998
2	Vehicle Operation and Performance	J. G. Giles	Wildlife Publications, London	1969
3	Automotive Engineering: Powertrain, Chassis System, and Vehicle Body	David Crolla	Butterworth-Heinemann	1st Edition, 2009
4	Fundamentals of Vehicle Dynamics	Thomas D. Gillespie	Society of Automotive Engineers, Inc.	1st Edition, 1992
5	Automotive Testing and NVH Engineering	Ganesan V.	McGraw-Hill Education	1st Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive technology	Dr. N.K.Giri	Khanna publishers	2009
2	Motor vehicle inspection	W. H. Crouse and L. Anglin	McGraw Hill Book Co.	1978
3	ARAI Standards https://www.araiindia.com/downloads			
4	SAE Hand book, Vol 3		SAE, Publications	2000

SEMESTER S8

HYDROGEN AND FUEL CELL VEHICLES

Course Code	OEMUT832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To acquire knowledge in hydrogen and fuel cell technology, including the basic properties of hydrogen, how fuel cells work, and their historical development.
2. To understand various hydrogen production methods and storage solutions, focusing on renewable technologies, safety considerations, and energy storage systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Hydrogen and Fuel Cell Vehicles: The importance of hydrogen as a clean energy carrier - Basic properties of hydrogen - An introduction to fuel cells and how they work - Historical development of hydrogen fuel cell technology - Comparison between hydrogen fuel cell vehicles and conventional internal combustion engine vehicles - Current trends and the future potential of hydrogen in the transportation sector - Overview of global initiatives and policies promoting hydrogen fuel cell vehicles.	9
2	Hydrogen and Fuel cell technology: Detailed operation of Proton Exchange Membrane Fuel Cells (PEMFC) - Key components of a fuel cell system- anode, cathode, electrolyte, catalyst. Electrochemical reactions in fuel cells - Fuel cell efficiency and performance metrics - Fuel cell stack design and vehicle integration - Challenges in fuel cell technology, degradation and lifetime issues - Innovations in fuel cell	9

	materials and designs - Comparative analysis of different fuel cell technologies - PEMFC, Solid Oxide Fuel Cells, Alkaline Fuel Cells.	
3	Hydrogen production methods- Steam methane reforming, electrolysis - Renewable hydrogen production and storage solutions (compressed gas, liquid hydrogen) - Safety in hydrogen handling and refuelling infrastructure - Energy storage in hybrid and electric vehicles, including battery-based, fuel cell-based, supercapacitor-based, and flywheel-based systems - Hybridization of energy storage devices - Short-term storage systems - flywheel accumulators, ultra-capacitors - Energy management strategies and implementation challenges.	9
4	Hydrogen Fuel Cell Vehicle Performance and Optimization: Vehicle Performance Metrics: Analysing the performance metrics of hydrogen fuel cell vehicles, including acceleration, range, and efficiency. Optimization Techniques: Techniques for optimizing fuel cell performance, including calibration, and tuning of fuel cell systems for different driving conditions, Cost Analysis and Lifecycle Assessment: Evaluating the cost of hydrogen fuel cell vehicles, including production, operation, and maintenance costs, along with lifecycle assessment. Real-World Applications: Case studies of hydrogen fuel cell vehicles in different applications- passenger cars, buses, trucks.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand hydrogen's role in clean energy, fuel cell operation, historical context, vehicle comparison, trends, and global hydrogen initiatives.	K2
CO2	Understand PEMFC operation, key components, performance metrics, stack design, challenges, innovations.	K2
CO3	Understand hydrogen production methods, storage solutions, safety, energy storage systems, hybridization, and energy management strategies and challenges.	K2
CO4	Understand the basic concepts in size drive systems, fuel cell matching, and integrate hybrid systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2		2		2		2		2	
CO2	2	2	2						2			2
CO3	2	2	2		2		2					2
CO4	2	2	2				2		2			

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hydrogen Fuel Cells for Road Vehicles	David A. J. Rand	Elsevier	1st Edition, 2017
2	Fuel Cell Technology: Principles and Applications	C. H. Wei	Wiley	2nd Edition, 2019
3	Hydrogen and Fuel Cells: Advances in Transportation and Energy	R. R. Rao	CRC Press	1st Edition, 2020
4	Introduction to Hydrogen Technology	K. K. Shukla	Springer	1st Edition, 2018
5	Hydrogen Production and Fuel Cells	A. B. Galindo	Academic Press	1st Edition, 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fuel Cells: Principles and Applications	Andrew L. Dicks and David A. J. Rand	Wiley	1st Edition, 2008
2	Hydrogen and Fuel Cell Technologies for Sustainable Development	R. T. S. A. Coleman and I. P. Gibbins	Springer	1st Edition, 2014
3	Hydrogen Storage Technologies: Materials and Applications	Michael A. K. K. Miller	Cambridge University Press	1st Edition, 2017
4	The Hydrogen Economy: The Creation of the Worldwide Energy Web and the Redistribution of Power on Earth	Jeremy Rifkin	TarcherPerigee	1st Edition, 2002
5	Fuel Cells and Hydrogen: A Comprehensive Guide	M. D. H. Hordeski	McGraw-Hill	1st Edition, 2010

Video Links	
Module No.	Link ID
1	Fuel Cell Technology - Chemical Engineering – IIT Delhi https://archive.nptel.ac.in/courses/103/102/103102015/
2	Hydrogen Energy: Production, Storage, Transportation and Safety By Prof. Pratibha Sharma IIT Bombay https://onlinecourses.nptel.ac.in/noc22_ch66/preview
3	Hydrogen Energy , IIT Bombay https://archive.nptel.ac.in/courses/103/101/103101215/

SEMESTER S8

INDUSTRIAL SAFETY ENGINEERING

Course Code	OEAUT833	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Mins
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart knowledge of various safety management principles and various safety systems
2. To compare different hazard identification tools and choose the most appropriate based on the nature of industry

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Need for safety: Safety and productivity. Definitions - Accident, injury, unsafe act, unsafe condition, dangerous occurrence, reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety officer-responsibilities, authority. Safety committee-need, types and advantages	9
2	Personal protection in the work environment: Types of PPEs, personal protective equipment, respiratory and non-respiratory equipment. Standards and Best Practices for PPE Selection, Use, and Maintenance. Monitoring safety performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping - responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system - objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.	9

3	Safety in Electrical and Electronic Systems- National and International Standards for Electrical Safety in Industrial Environments. Importance of Grounding and Bonding in Electrical and Electronic Systems. Principles of Safe Design in Industrial Electronics. Managing Electromagnetic Interference (EMI) and Compatibility (EMC). ESD Prevention and Control in Electronics Manufacturing and Assembly. Innovations in Safety Technology - New Technologies in Safety Engineering: Smart Sensors, Predictive Analytics, and Automation. Future Trends in Industrial Safety: AI and Machine Learning Applications. Case Studies.	9
4	Hazard identification and analysis: Hazard and risk, types of hazards – classification of fire, types of fire extinguishers, fire explosion and toxic gas release, structure of hazard identification and risk assessment. Identification of hazards - inventory analysis, fire and explosion hazard rating of process plants, - dow fire and explosion hazard index, preliminary hazard analysis, hazard and operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of chemical hazards, hazardous properties of chemicals, material safety data sheets (MSDS). Importance of Safety Documentation - Types of Safety Documents: Safety Procedures, Risk Assessments, Incident Reports, Record Keeping for Compliance and Audit , Checklist.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental concepts of workplace safety, and the roles of various stakeholders, promoting a safer work environment	K2
CO2	Demonstrate competency in selecting, utilizing, and maintaining personal protective equipment (PPE), and implementing safety protocols like housekeeping and work permit systems to enhance workplace safety	K2
CO3	Apply electrical safety standards, implement effective grounding and bonding, design safe electronic systems, and ensure software safety through secure coding practices, risk management, and failure analysis.	K3
CO4	Apply proficiency in identifying, assessing, and managing hazards and risks associated with chemical processes and fire safety, utilizing methodologies like HAZOP and Dow Fire and Explosion Hazard Index to ensure workplace safety.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2							
CO2	2	2				2						
CO3	2	3	2	2		2						
CO4	2	3				2						

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Safety, Health and Environment management systems	R.K Jain	Khanna Publications	2000
2	Safety and Health for Engineers	Roger L. Brauer	Wiley	2016
3	Safety management system	Waring, Alan	Chapman & Hall, England	1996

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Safety management in Industry	Krishnan, N.V.	Jaico Publishing House, New Delhi.	1997
2	Industrial safety	Ronald P. Blake	Prentice Hall, New Delhi.	1992
3	Introduction to Electrical Safety	Robert W. S. Harvey	CRC Press	2012

Video Links	
1.	Industrial Safety Engineering, By Prof. Jhareswar Maiti IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_mg43/preview
2.	Industrial Safety And Fire Safety Management , By Dr. P.K.Ghosh & Mrs.Annapurna Adiley Chhattisgarh Swami Vivekanand Technical University (CSVТУ), Bhilai , https://onlinecourses.swayam2.ac.in/nou23_ge81/preview