SEMESTER 3

MECHANICAL ENGINEERING (AUTOMOBILE)

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	10th 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	3rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1st edition, 2011

SEMESTER S3

AUTOMOTIVE SYSTEMS

Course Code	PCMUT302	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. Study general layout, components and its working of Front axle, rear axle, steering system, and final drive system.
2. Describe the construction and working of different types of braking systems and suspension system.
3. Understand the construction, types of tyres, wheels, and the testing methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Automobile Systems-** Classification of automobiles- Layout with reference to prime mover location and drive, Frames- types, Sections, Constructional details –Materials – Integrated body construction- loads acting frame members, Chassis Specifications. Layout of hybrid and electric vehicles. **(**4 Hours) **Front axle and Steering Systems: -** Front Axle types. Construction details. Materials. Front wheel geometry, Wheel alignment parameters- description and importance. Steering mechanisms, Conditions for true rolling, Ackermann and Davis steering gear mechanisms, Steering linkage layout for conventional and independent suspensions. Steering gear boxes- Worm and	11

	wheel, Recirculating ball, Rack and pinion, Power and power assisted steering – Electric steering. (7 Hours)	
2	**Rear Axle and Final Drive system: -** Function of rear axle, Construction, Loads acting on rear axle, Axle casings, Axle types - semi-floating, three quarter and full floating. Final drive for multi-axle vehicles. Different types of final drives, U joint, Propeller shaft, Differential, Constructional details and working of differential unit, non-slip and Limited slip differential, Differential lock, Differential housing, Final drive lubrication. (6 Hours) **Braking systems: -** Components of Braking system, Principles of shoe brakes- Constructional details of Internal expanding shoe brakes, Self-energising, self-locking braking, Disc brakes - constructional details, hydraulic braking system – components, working, Tandem master cylinder-construction, working. Pneumatic brakes- Power Brakes-Air brakes, vacuum brakes, servo brakes -Components, Brake actuating mechanisms. Brake fluids. Regenerative brakes in Electric vehicles. Parking brakes, Antilock braking system (ABS), brake bleeding, (6 Hours)	**12**
3	**Suspension Systems** Types of suspension. Factors influencing ride comfort, Suspension springs – leaf spring types, shackle and mounting brackets, coil, and torsion bar springs. Spring materials, independent front, and rear suspension systems, Pneumatic, hydro-elastic, hydro-gas suspension, Active suspension system. Hydraulic dampers, Gas filled dampers. **(6 Hours)** **Tyres and Wheels** Types of wheels, Tyres, Types -Tubed and Tubeless, Radial, bias belted tyres - constructional details, tyre aspect, ratio, tyre specifications, Wheel balancing and wheel alignment. wheel wobble and shimmy. **(5 Hours)**	**11**
4	**IC Engine Cooling system: -** Necessity of engine cooling, Air cooling and Liquid cooling, Pressure sealed cooling, components of liquid cooling system, coolants, antifreeze solution. **(4 Hours)** **Engine Lubricating system: -** Requirements of lubrication systems. Types of Lubrication system, - Mist, Splash, Wet Sump, and Dry Sump Lubrication System. Multi grade lubricants, Pre-lubrication systems. **(4 Hours)** **Electric Vehicle systems**: -Electric vehicles drive systems, Storage systems, Battery Management systems, Thermal Management systems, **(2 Hours)**	**10**

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 Layout, components, and functions of Automobile chassis.	**K2**
CO2	Explain the constructional features and characteristics of Front axle, rear axle, Steering system, and Drive system.	**K2**
CO3	Discuss the components and working of Braking system and Suspension system	**K2**
CO4	Cooling and lubrication system	**K2**
CO5	Understand the constructional features and types of Automotive Tyres and wheels	**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	3	1									2
CO4	3	2	1									2
CO5	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	Automobile Engineering-Volume 1	Dr. Kirpal Singh	Standard Publishers and distributors	14th Edition, 2021
2	A Textbook of Automobile Engineering	S.K. Gupta	S Chand Publishers.	2nd Edition, 2020
3	Automobile Engineering	K K Jain and R B Asthana	Mc Graw Hill	2012
4	A Textbook of Automobile Engineering.	R.K. Rajput	Laxmi Publications	2007

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Technology	Jack Erjavec	Delmar Cengage learning	2009
2	Automotive Mechanics	William H. Crouse and Donald L	Mc Graw- Hill	10th edition, 2007.
3	Electric and Hybrid Vehicles	Tom Denton and Hayley Pells	Taylor and Francis group	3rd Edition 2024.

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/107/106/107106088/ https://youtu.be/fTnAoYBKXFU
2	https://youtu.be/dBHOMtGquuo https://youtu.be/UTvKhdvFM_s https://youtu.be/RjmaHqpH-eg
3	https://youtu.be/GinzMttVE1M

SEMESTER S3

FLUID MECHANICS AND MACHINERY

Course Code	**PCMET303**	**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. To establish fundamental knowledge of basic fluid mechanics and its simple applications.
2. To familiarize students with the relevance of turbo machines and find solutions to the associated engineering problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Prerequisite: Properties of fluid: Specific gravity, Specific Weight, Specific Volume, Dynamic and Kinematic Viscosity. Introduction to fluid mechanics - Types of fluids, Newton's law of viscosity. Pressure Measurement: Fluid pressure, Pressure head, types of pressures. Piezometer, Simple, differential Manometers. Fluid statics: Pressure, density, height relationship. Hydrostatic force and pressure on plane and inclined surfaces, Centre of pressure. Buoyancy and Metacentre. Stability of immersed and floating bodies.	8
2	Fluid kinematics: Description of fluid motion – Types of flows, Material derivative velocity and acceleration – Streamlines, path lines and streak lines, Stream function and velocity potential function, flow net . Fluid dynamics: Continuity equation, Euler's, and Bernoulli's equations. – Measuring instruments – Pitot tube, Orificemeter, Venturimeter, Rectangular and Triangular Notches-(notches Problems not required).	8

3	Pipe flow – laminar and turbulent flows, significance of Reynolds number, shear stress and velocity distribution in a pipe flow.– Hagen-Poiseullie equation, Darcy-Weisbach equation and Chezy's equation , Moody's chart for estimating frictional losses, Major and minor energy losses, hydraulic gradient, and total energy line. Navier-Stokes equation and explanation (without proof) . Dimensional analysis using Buckingham's π, theorem. Boundary layer theory: Qualitative comparison between laminar and turbulent boundary layer. Boundary layer separation.	**12**
4	Impact of jets: Impact of jet on fixed vertical, moving vertical flat plates. Impact of jet on curved vanes – fixed and moving. Velocity triangles. Classification of Turbines and pumps Comparison and examples. Pelton, Francis and Kaplan Turbines: Principle and working, head, work done, efficiencies (Problems using velocity triangles not required). Centrifugal Pumps: Principle and working, head, work required, efficiencies, Priming and cavitation.(Problems using velocity triangles not required) . Reciprocating Pump: Principle and working – slip,negative slip, work required and efficiency.	**12**

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	Identify the fundamental fluid properties, their relationships and apply them to estimate the fluid pressure and hydrostatic forces on bodies	**K3**
CO2	Classify the fluid flow and apply the principles kinematic and dynamics using the conservation of mass and momentum equations.	**K3**
CO3	Analyse viscous flow through pipes and estimate the major and minor losses associated with piping network.	**K3**
CO4	Understand the basic concept of dimensional analysis.	**K3**
CO5	Select suitable turbo machine for specific application by identifying the pertinent parameters	**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										
CO2	3	3	2									
CO3	3	3										
CO4	3	2										
CO5	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	Fluid Mechanics	Cengel Y. A. and J. M. Cimbala	Tata McGraw Hill	2013
2	Introduction to Fluid Mechanics and Fluid Machines	Som S.K.	McGraw Hill Education India	2011
3	Fluid Mechanics and Hydraulic Machines	Bansal R.K.	Laxmi Publications	2005

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fluid Mechanics	White F.M.	Tata McGraw Hill	2003
2	Engineering applications of Fluid dynamics	Fisher and Henly	Willford Press	2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Fluid Statics https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4 Bouyancy, Metacentre and stability https://www.youtube.com/watch?v=gMuucNxc7eI&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw&index=7&pp=iAQB
2	Fluid kinematics https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4
3	Internal Viscous Flow https://www.youtube.com/watch?v=qLx7ip0eBps&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2&index=17
4	Introduction to turbomachines https://www.youtube.com/watch?v=ocVzrn4DLj8&list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&index=2

SEMESTER S3

MANUFACTURING PROCESSES

Course Code	PBMET304	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 gain theoretical and practical knowledge in manufacturing processes and to develop and understanding of the dependent and independent variables which control a production processes.
2. Provide a detailed discussion on the welding process and the physics of welding. Introduce students to different welding processes weld testing and advanced processes tobe able to appreciate the practical applications of welding.
3. Generate solutions to problems that may arise in manufacturing engineering

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	General Classification of Manufacturing Processes. Casting-Characteristics of sand, design of patterns, cores, chaplets, solidification of metals and Chvorinov's rule, elements of gating system, risers, chills, numerical problems, defects in castings. Special casting process- Shell moulding, precision investment, die casting, centrifugal casting, continuous casting and squeeze casting. Powder Metallurgy- Powder Production, powder characteristics, mixing, compaction methods, sintering.	9

2	Welding: Classification, Fusion and Solid-state welding processes. Gas Welding - Oxyacetylene welding-chemistry, types of flame and its applications. Arc welding- applications, process parameters, numerical problems, consumable and non-consumable arc welding, SMAW; GTAW; GMAW; SAW; AHW; PAW. Thermit welding, friction welding, electro slag welding, ultrasonic welding, electron beam welding, laser beam welding. Resistance welding-applications, process parameters, numerical problems. Heat Affected Zone, weldability of ferrous and non-ferrous metals, residual stresses and distortion, defects in welding. Brazing - soldering - adhesive bonding	**9**
3	Metal Forming: Plastic deformation and yield criteria − hot and cold working processes. Rolling- Flat-rolling process, rolling force and power, numerical problems, types of rolling mills, rolling defects, miscellaneous rolling processes. Sheet metal operations- Press tool operations-Shearing, Tension, Compression, Tension and compression operations, applications, numerical problems. Types of die-Progressive dies, Compound dies, and Combination dies	**9**
4	Forging-Forging load, numerical problems, Various methods, applications, defects in forging - Wire, Rod, and tube drawing - mechanics of rod and wire drawing, drawing force and power, numerical problems, drawing defects – Deep drawing. Bending – Details of bending, Determination of work load, estimation of spring back, numerical problems. Extrusion- Metal flow, mechanics of extrusion, numerical problems, miscellaneous processes, defects in extrusion, applications	**9**

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	Classify different techniques of casting	**K2**
CO2	Summarize powder metallurgy processes	**K2**
CO3	Categorize welding processes according to welding principles and materials.	**K2**
CO4	Determine forming load associated with rolling, forging, drawing, extrusion, and sheet metal forming	**K3**
CO5	Develop products, processes or technologies for socially relevant applications.	**K3, K4, 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										
CO2	3	2										
CO3	3	2										
CO4	3	3										
CO5	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	Manufacturing Science	Amitabha Ghosh Asok Kumar Mallik	Affiliated East-West Private Limited	2nd Edition 2010
2	Manufacturing Engineering and Technology	Serope Kalpakjian Steven R. Schmid	Pearson	
3	Manufacturing Technology Volume -1	P N Rao	Tata McGraw Hill	

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	American Society for Metals - ASM Metals Handbook, Vol. 14	Joseph R. Davis, S. L. Semiatin,	Forming and Forging ASM International	1989
2	Tool design	Donalson cyril, LeCain, Goold, Ghose:-	McGraw Hill	
3	Cold and Hot Forging Fundamentals and Applications	Taylan Altan, Gracious Ngaile, Gangshu Shen	ASM International	2004
4	Foundry Technology	Peter Beeley	Butterworth-Heinemann	

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 approach

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								
CO5	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	6th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2nd edition,2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1st edition, 2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1st edition, 2019
5	Probability and Statistics - The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1st 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

(Common to All Branches)

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. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	6

2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	**6**
3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	**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 - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	**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 =18marks)**	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, national income and stock market.	**K2**
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and 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

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

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	6

	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.	

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	A comprehensive presentation summarising the key takeaways	G	5

	Presentation	from the course, personal reflections, and proposed future actions based on the learnings.		
			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 Profession al Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainabil ity 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 & Assessmen	2019
5	Engineerin g Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Profession al ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineerin g	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 HYDRAULIC MACHINES LAB

Course Code	PCMUL407	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 familiarize the applications of fluid mechanics and dynamics.
2. To get acquainted with the practical implication of viscous flow and discharge measuring equipment in both closed & open channel flow.
3. To gain practical experience in handling various hydraulic machines.

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

12	Performance test on Centrifugal pumps and determination of operating characteristics.
13	Performance test on Gear pump.
14	Performance test on Pelton turbine and determination of operating characteristics.
15	Performance test on reaction turbines (Francis and Kaplan Turbines) and determination of operating characteristics.
16	Speed variation test on Pelton turbine.

Minimum 10 experiments should be completed

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	Apply the fundamental principles of fluid mechanics to understand the flow of fluid through pipes, notches, and associated losses.	**K3**
CO2	Select a pump/turbine based on the given operating conditions and determine the performance of a given Turbo machine under various operating conditions.	**K4**
CO3	Demonstrate the ability to work in groups and present results. Also, understand the ethical issues with decision making and professional conduct.	**K5**

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	3										
CO2	3	3	2	2		2						2
CO3								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	Fluid Mechanics	Cengel Y.A. and J.M. Cimbala	Tata McGraw Hill	2013
2	Introduction to Fluid Mechanics and Fluid Machines	Som S.K.	McGraw Hill Education India	2011
3	Fluid Mechanics and Hydraulic Machines	Bansal R.K.	Laxmi Publications	2005

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fluid Mechanics	White F.M.	Tata McGraw Hill	2003
2	Engineering applications pf Fluid dynamics	Fisher and Henly	Willford Press	2023

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	Fluid Statics https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4 Bouyancy, Metacentre and stability https://www.youtube.com/watch?v=gMuucNxc7eI&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw&index=7&pp=iAQB
2	Fluid kinematics https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4
3	Internal Viscous Flow https://www.youtube.com/watch?v=qLx7ip0eBps&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2&index=17
4	Introduction to turbomachines https://www.youtube.com/watch?v=ocVzrn4DLj8&list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&index=2

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

AUTOMOTIVE SYSTEMS LAB

Course Code	**PCMUL308**	**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. Give a basic knowledge of various hand tools, special purpose tools and equipments used for maintenance and repair of the Automotive systems.
2. Give a hands-on experience in disassembling, inspecting, servicing, and reassembling various vehicle systems and components.
3. Equip students with the practical skills necessary for diagnosis, and adjusting the clutch, gear box, differential assembly, and steering mechanisms, ensuring optimal performance and safety.
4. Enable students to perform diagnostic tests and measurements, such as compression tests, emission checks, wheel alignment, and wheel balancing.

Expt. No.	Experiments
1	Study of General Tools and Equipments used in Automotive systems.
2	Dismantling and Servicing of Single plate clutch/Diaphragm clutch assembly.
3	Dismantling of differential assembly, servicing, backlash adjustments, check for drive axis ratio.
4	Servicing master and wheel cylinders in hydraulic brake system and conduct bleeding of brakes.
5	Study of steering system. Servicing of Recirculating steering gear box, checking for end play in shafts.
6	Dismantling of gear box, inspecting components, servicing, checking the gear ratios.
7	Dismantling and Overhauling of a strut type suspension system.

8	Tyre codes, Tyre removing, inspection, check for cuts, bulges, and excessive tread wear, resetting using pneumatic tyre changer
9	Checking and adjusting the wheel alignment parameters with the help of computerized wheel alignment machine.
10	Cylinder reconditioning using vertical cylinder reboring machine.
11	Disassembling and servicing of main and helper spring assembly
12	Dismantle and assemble Constant Velocity joint. Also examine the slip joint and universal joint in propeller shaft.
13	Checking the emission of gasoline engine with exhaust gas analyser and checking the emission of diesel engine with diesel smoke meter.
14	Disassembling of engine cylinder block and inspection/servicing of engine components, servicing of components, find ovality and taperness.
15	Compression test of petrol and diesel engine.
16	Disassembling cylinder head, decarbonizing and study of valve actuating mechanisms-Checking/setting correct Valve timing and valve clearance adjustment.
17	Testing of Fuel injector and Fuel pump– testing the pressure of mechanical diesel injector, spray pattern, adjusting of injection pressure.
18	Brake force measurements using a Two-wheeler Brake tester.
19	Check ignition timing of Battery/Magneto ignition system.

Minimum 12 experiments should be completed

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 Practical	N Malhotra	Asian Publishers	Jan 2022
2	Automobile Engineering with Practicals	R. B. Gupta	Satya Prakashan	2020

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Engineering, Volume 1 and Volume 2	Dr Kripal Singh	Standard Publishers distributors	Dec 2020
2	Automotive Mechanics	William H Crouse Donald L Anglin,	Tata McGraw Hill Publishing	10th Edition 2017

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

MECHANICAL ENGINEERING(AUTOMOBILE)

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 t-distribution), Hypotheses and Test Procedures, Type I and Type II error, z Tests for Hypotheses about a Population Mean (for large sample), t Test for Hypotheses about a	9

	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]**	
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	9th edition, 2016
2	Introductory Methods of Numerical Analysis	S S Sastry	PHI Learning Pvt Limited	5th 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 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 od 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 THERMAL SYSTEMS

Course Code	**PCMUT403**	**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. This course provides an understanding of the fundamental principles of thermodynamics to apply energy conservation principles to closed and open systems.
2. Students will acquire knowledge in the thermodynamic analysis of thermal systems used for power generation and refrigeration

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Basic concepts of Thermodynamics** - Microscopic & macroscopic approach, thermodynamic system and control volume, types of thermodynamic systems, State and equilibrium, thermodynamic properties, Processes and cycles, Quasi-static process. Concepts of heat and work transfer- displacement work and other modes of work. Zeroth law of Thermodynamics- concept of temperature and thermal equilibrium, temperature scales (description only), Various thermometers. **(5 Hours)** **First law of thermodynamics-** Concept of energy and various forms of energy- internal energy, enthalpy, specific heats. First law applied to a closed system undergoing change of state and a cycle, PMM1, Steady flow energy equation- applied to steady flow engineering devices- turbines, pump, compressors, nozzles, throttling process - Derivation and simple problems. **(6 Hours)**	**11**

2	**Second law of thermodynamics:** Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, PMM2, Carnot theorem, corollary of Carnot theorem, thermodynamic temperature scale. Concept of entropy, causes of irreversibility, Clausius inequality, Principle of increase of entropy. Availability and irreversibility, Third law of thermodynamics, concept of exergy.**(6 Hours)** **Air standard cycles:** Otto and Diesel cycle, Dual cycle, air standard efficiency, mean effective pressure, relative efficiency. **(4 Hours)**	**10**
3	**Refrigeration systems -** Unit of refrigeration, Refrigeration effect & C.O.P Refrigerants- Classification of refrigerants, desirable properties of refrigerants. Refrigeration cycles - Reversed Carnot cycle, Reversed Joule cycle, vapour compression cycle, Vapor-absorption cycle, Components of refrigeration system, working, representation on T-S and P-H diagrams, simple problems. **(6 Hours)** **Compressors** – Reciprocating compressors- Principle of operation, work required, isothermal and volumetric efficiencies, multi-stage compression, minimum work condition for multi-stage compression. -simple problems, Rotary compressors- mechanical details and working principle (description only) **(4 Hours)**	**10**
4	**Gas turbines** - Classification, Thermodynamic analysis of gas turbine cycles-open, closed and semi closed cycle; ideal working cycle- Brayton cycle-P-V and T-S diagram, thermal efficiency. Effect of compressor and turbine efficiencies. Comparison of gas turbine and IC engines, Analysis of open cycle gas turbine, Improvements of the basic gas turbine cycles-regeneration, intercooling and reheating- cycle efficiency and work output. . Combustion chambers for gas turbines. (8 Hours) **Fuels and Combustion-** Types of fuels, Properties of fuels, Combustion equations, Combustion analysis by mass and volume - Conversion of gravimetric to volumetric analysis - Conversion of volumetric to gravimetric analysis, Analysis of fuel combustion-Air fuel ratio, equivalence ratio, minimum quantity of air, flue gas analysis, excess air. (4 Hours)	**12**

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 concepts and laws of thermodynamics	**K2**
CO2	Understand various thermodynamic cycles and estimate the efficiency and performance characteristics.	**K2**
CO3	Understand the basics of Refrigeration and airconditioning and estimate the effectiveness and performance characteristics.	**K2**
CO4	Understand the working principle and performance parameters of Compressors and gas turbines	**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										1
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	Engineering thermodynamics	P.K. Nag	Tata McGraw-Hill Publishing Company Ltd.	Sixth edition, 2017
2	Engineering Thermodynamics	R.K. Rajput	Laxmi Publications	
3	Thermal Engineering	P. L. Ballaney	Khanna Publishers	25th edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thermodynamics: Engineering Approach,	Yunus A. Cengel Michael A. Boles,	Tata McGraw-Hill Publishing Company Ltd.	Ninth edition, 2019
2	Fundamentals of Thermodynamics	R.E. Sonntag and C. Borgnakke,	John Wiley & Sons	Tenth edition.2022

Video Links (NPTEL, SWAYAM…)	
Module No.	Link ID
1	https://www.youtube.com/watch?v=9GMBpZZtjXM
2	https://youtu.be/c2Fwkkjl_h0?list=PLwdnzlV3ogoWV-_n1YItO933MxgPXfEiM
3	https://youtu.be/kC-VswG3W8s?list=PLwdnzlV3ogoWV-_n1YItO933MxgPXfEiM
4	https://youtu.be/OAbN0udD3cI?list=PLwdnzlV3ogoWV-_n1YItO933MxgPXfEiM https://youtu.be/trAt_x1tev8?list=PLwdnzlV3ogoWV-_n1YItO933MxgPXfEiM

SEMESTER S4

AUTOMOTIVE ENGINES AND TRANSMISSION

Course Code	PBMUT404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart theoretical and practical knowledge of IC Engine components.
2. To identify the components, characteristics and functions of the air and fuel supply system of internal combustion engines.
3. Understand the working principle and characteristics of various types of clutches in manual and automatic transmission systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to automobile IC engines**: Engine nomenclature, classification of IC engines by cylinder arrangement and Valve arrangement. Numbering of cylinders, firing order. **(3 Hours)** Constructional details of engine components: - Engine block, head and crank case, cylinder liners, piston, piston rings, piston pins, connecting rod, crank shaft, flywheel, Main Bearings, camshaft, valves, inlet, and exhaust manifold, Valve actuating mechanisms. **(6 Hours)** **Air intake system in petrol and diesel engines: -** Layout, components, air filter- types and construction. **(2 Hours)**	**11**
2	**Fuel supply system in petrol engines:** Components of fuel feed systems, carburetion, properties of air- fuel mixtures, mixture requirements for steady state & transient operations, simple carburettor with circuits. **(4 Hours)** **Fuel supply system in diesel engines:** Components of diesel injection system, diesel air filters- types, Diesel injection pumps, Modem distributor type pumps, injection nozzles, governors (vacuum and centrifugal), cold	**12**

	starting devices, Turbocharging and supercharging in IC engines **(6 Hours)** **Electronically controlled engines**- MPFi engines, GDi engines, TSi, CRDi- Layout, components and working. **(2 Hours)**	
3	**Automotive Clutches:** Principle of operation, constructional details of single plate, multi-plate, diaphragm, centrifugal clutches, and Electromagnetic clutch. Friction lining materials, Clutch actuating mechanisms. **(5 Hours) Automotive Gear box:** Need of Gear box, Construction and working principle of constant mesh, and synchromesh gear boxes. gear shifting mechanisms. **(5 Hours)**	**10**
4	**Automatic Transmission:** Components of automatic transmission- Hydrostatic drive, Principle of hydrostatic transmission system, Basic construction, Types of hydrostatic drives. Hydrodynamic drives, Fluid flywheel, Torque convertor, Continuously Varying Transmission: Components of CVT, Types of CVT. **(7 Hours)** Gear shift valve, vacuum and governor valve, sensors, and actuators, PCM, TCM, Hydraulic and Electronically controlled systems of automatic transmission - AMT, DSG/ DCT transmission **(4 Hours)**	**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	To analyse the performance of Internal combustion engines	**K5**
CO2	Examine the fuel supply systems in SI and CI engines	**K4**
CO3	Examine the construction and working of different types of automotive clutch and gearbox and their application in automobiles.	**K4**
CO4	Assess the performance of hydrostatic drives and automatic transmission systems	**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	2	2	1	1	2	-	-	-	-	-	-	-
CO3	2	2	1	1	2	-	-	-	-	-	-	-
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	Automobile Engineering Volume 2	Kirpal Singh	Standard Publishers and distributors	14th Edition 2020
2	Automotive Mechanics	N.K.Giri	Khanna Publishers	2013
3	Internal Combustion Engines	Ganesan. V	Tata McGraw-Hill Publishing Co	4th Edition 2017
4	Automobile Engineering	K K Jain and R B Asthana	Mc Graw Hill	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	A course in internal combustion Engines	Mathur. M.L., Sharma. RP	Dhanpatrai publication	2016
2	Internal Combustion Engines Fundamentals	John Heywood	McGraw Hill International Edition	2nd Edition 2018
3	Fuels & Combustion	Smith, Marion L. And Karl W. Stinson	McGraw-Hill	2016
4	Heinz Heisler, Butterworth-Heinemann	Advance vehicle Technology		2nd Edition 2002

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/107/106/107106088/
2	https://archive.nptel.ac.in/courses/107/106/107106088/
3	https://archive.nptel.ac.in/courses/107/106/107106088/
4	https://archive.nptel.ac.in/courses/107/106/107106088/

Suggestions:

The following mini projects/case studies can be provided

1. Study and comparison of different types of Engines used in 2 and 4 wheels
2. Enhanced learning through dismantling, identification and servicing of an IC Engine
3. Comparison of different types of Clutch mechanism used in 2 and 4 wheelers

Study on the working of gear box and identification of torque multiplication process, gear teeth profiles, gear ratio, etc.

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

ALTERNATIVE FUELS AND ENERGY SYSTEMS

Course Code	**PEMUT411**	**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 basic characteristics of fuels & fuel additives.
2. To understand various types of alternative fuels and their environmental impacts
3. To understand the production, storage and handling techniques of hydrogen fuel technologies.
4. To understand the potential of Electric and Fuel Cell Vehicles

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fuels** - Classification, Types, Combustion equations, Stoichiometry, Combustion analysis of fossil fuels by mass and volume – calculation of air quantity **Fuels Properties-** Calorific value, Viscosity, Flash & Fire point, Octane no, Cetane no., Properties for SI Engine fuels & CI Engine fuels, Fuel properties affecting engine performance. Emissions – main pollutants & its control, **Fuel Additives** – Need, Types, commonly used additives.	**9**
2	**Alternative fuels** – Advantages and disadvantages of conventional fuels, Need for alternative fuel, Types of Gaseous alternate fuels - LPG, CNG, LNG, Types of Liquid alternate fuels- Alcohol, Ethanol, Methanol, Di-Methyl Ether, Di-Ethyl Ether. Availability, performance, emission and desired properties of alternate fuels, Relative merits, and demerits of alternate fuels. **Biofuels** - Biodiesel and Biogas, production, blending criteria, blending	**9**

	process, Advantages of blending, Performance and emission of biodiesel fuelled vehicles.	
3	**Hydrogen Fuels** – Sources of hydrogen, Production methods, Storage and handling, Hydrogen Induction Techniques in IC engines, Modifications required in the engine for hydrogen fuel, Performance and emission characteristics, Safety aspects **Fuel Cell Vehicles -** Layout of a Fuel Cell vehicle, Fuel cell types - alkaline fuel cell. Proton exchange Membrane; direct methanol fuel cell. Phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, power rating and performance.	**9**
4	**Electric Vehicle -** Layout of an electric vehicle, advantages and limitations, specifications, system components, high energy and power density batteries, **Hybrid vehicles -** components, advantages and disadvantages, Application. 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**

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 understand the differences between conventional fossil fuels, alternative fuels and Biofuels.	**K2**
CO2	Acquires the knowledge of properties of hydrogen and hydrogen vehicles	**K2**
CO3	To understand basic concepts of Electric, Hybrid and Fuel Cell Vehicles	**K2**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2					1					2
CO2	1	2					1					2
CO3	1	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	Alternative fuels and Advanced vehicle technologies	Kavati Venkateswarlu B S R Murthy	PHI Learning	2020 January
2	Alternative Energy Systems and Applications	B.K Hodge	WILEY	2nd Edition, 2017
3	Alternative Fuels	S.S.Thipse	Jaico Publications	1st Edition, 2010.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Alternative Fuels Guide Book	Richard.L. Bechfold	SAE International Warrendale	1997
2	Alternative Fuels: The Future of Hydrogen.	Michael Frank Hordesk	River publishers	3rd Edition,

SEMESTER S4

COMPOSITE MATERIALS AND CERAMICS

Course Code	**PEMUT412**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	2:1:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To impart the fundamental knowledge, concepts, applications, special characteristics, and fabrication methods of different classes of ceramics.
2. To describe key processing techniques for producing polymer, metal, ceramic, and carbon matrix composites.
3. To demonstrate the relationship among processing, and properties in composite materials.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Ceramics:** Definition and scope of ceramics, Classification, Traditional ceramics, Ceramic coatings, Glass, Refractories, Advanced ceramics, Properties and applications of ceramics. **Ceramic processing and fabrication techniques** – Quarrying, Mechanical separation, Mixing, Conveying and storage, Slip forming, Plastic forming, Dry forming, Drying and finishing, Firing**.**	**8**
2	**Introduction to Composites:** Introduction, Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement and matrix. **Types of reinforcements and their properties:** Fibers – Glass, Boron, Carbon, Aramid, Ceramic, Whiskers, Comparison of fibers. Role of interfaces: Wettability and Bonding, Interactions and types of bonding at the Interface.	**9**

3	**Polymer matrix composites (PMC):** Thermoset, Thermoplastic and Elastomeric polymers, Properties, characteristics and applications as matrix materials, Processing methods: Hand lay-up, Spray-up, Moulding methods - Pressure bagging and bag moulding methods, Autoclave-based processing with prepregs, Pultrusion and filament winding. **Metal matrix composites (MMC):** Classification of metals, intermetallics, alloys and their potential role as matrices in composites, properties, characteristics and applications of metals as matrix materials, Production techniques: Powder metallurgy, Diffusion bonding, Melt stirring, Squeeze casting, Liquid infiltration under pressure, Insitu process.	**10**
4	**Ceramic matrix composites (CMC):** Introduction, properties, characteristics and applications, Fabrication methods: Cold pressing and sintering, Hot pressing, Reaction bonding, Lanxide process, Insitu chemical technique, Sol-gel technique. **Carbon fiber/Carbon matrix composites:** Processing of Carbon/Carbon Composites, Oxidation protection of Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, and application of Carbon/Carbon Composites. **Nonconventional Composites:** Introduction, Nanocomposites; Polymer clay nanocomposites, self-healing composites, self-reinforced composites. Bio composites, Laminates; Ceramic Laminates, Hybrid Composites.	**10**

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	Define and classify various types of ceramics, identifying their properties and applications.	**K2**
CO2	Describe the history, matrices, and reinforcements of composites, detailing the types, structures, properties, applications, and manufacturing processes of fibers and whiskers.	**K2**
CO3	Explain the classification, properties, characteristics, applications, and manufacturing methods of polymer and metal matrix composites, including the role of alloys and intermetallics.	**K2**
CO4	Identify and describe the properties, characteristics, applications, and manufacturing methods of ceramic matrix composites.	**K2**
CO5	Classify and explain the properties, characteristics, applications, and manufacturing methods of carbon fiber/carbon matrix and nonconventional composites.	**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
CO2	3											2
CO3	3					1						1
CO4	3					2						2
CO5	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	Introduction to Ceramics	W. D. Kingery, H. K. Bowen and D. R. Uhlmann	John Wiley & Sons	2nd Ed., 1991
2	Introduction to Ceramics – Fabrication, Characterizations, and Applications	Sujoy Bose and Chandan Das	CRC Press, Taylor and Francis ISBN: 978-0-367-75057-2	2024
3	Composite Material Science and Engineering	Krishan K. Chawla	Springer ISBN: 978-0-387-74364-6	3rd Ed., 2015
4	Engineering Materials: Polymers, Ceramics and Composites	A.K. Bhargava	PHI Learning ISBN: 9788120346215	2nd Ed., 2012

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to the Principles of Ceramic Processing	J. S. Reed	John Wiley & Sons	1995
2	Fundamentals of Ceramics	Michel Barsoum	CRC Press, Taylor and Francis	2019

SEMESTER S4

VEHICLE BODY ENGINEERING

Course Code	PEMUT413	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. Study the constructional details and body styles of car, bus, and commercial vehicles.
2. Understand the techniques to estimate various forces and moments acting on a vehicle.
3. Understand various materials and techniques used in vehicle body construction and painting

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Car Body Details-** Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car –Vehicle visibility regulations, driver's visibility, improvement in visibility and tests for visibility. Driver and passenger seat, Various dashboard instruments in passenger car	9
2	**Bus and commercial vehicles body details-** Types of bus body: Mini bus, single-decker, double-decker, two level, split level and articulated bus, floor height, engine location, entrance and exit locations, seating dimensions, Types of commercial vehicle bodies, Construction details of commercial vehicle body – Flat platform body, Trailer, Tipper body and Tanker body	9
3	**Vehicle aerodynamics-** Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels –Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of various forces and moments by using wind tunnel	9

4	**Vehicle Body Materials, and Painting -** Types of materials used in body construction-Steel sheet, timber, plastics, GRP, properties of materials, Paint types & characteristics, Painting methods and techniques – Spraying, Immersion. Painting equipment, Painting procedure, Different types of paint defects occurring during painting & drying	**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 various styling forms of car body	**K2**
CO2	Understand the various types and styles of bus and commercial body	**K2**
CO3	Understand the various aspects of vehicle aerodynamics	**K2**
CO4	Illustrate materials for vehicle body building and painting procedure	**K1**

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
CO2	2	1	2	-	-	-	-	-	-	-	-	1
CO3	3	2	2	-	2	-	2	-	-	-	-	-
CO4	1	1	1	-	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	Handbook of Automotive Construction and Design Analysis	John Fenton	John Wiley & Sons	2014
2	Vehicle Body Engineering	A.K Babu	Khanna Publishing house	2021
3	Aerodynamics of road vehicles, 4th edition	Wolf-Heinrich Hucho	Society of Automotive Engineers,U.S	2000

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Vehicle Body Engineering	Powloski, J	Business Books Ltd	1998.
2	Automotive Chassis & Body	Kohli P. L, “	Papyrus Publishing House, New Delhi	2010
3	“Vehicle Aerodynamics”,	Sumantran V. and Gino Sovram,	SAE International, USA,	1994

SEMESTER S4

ADVANCED METAL JOINING TECHNIQUES

Course Code	**PEMET416**	**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 establish fundamental knowledge Advanced welding technologies
2. To enable the learner to select appropriate metal joining technique based on the application.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Solid State Welding**: Principle and mechanism of solid-state welding, techniques, process parameters and applications of diffusion welding, cold pressure welding. **Adhesive Bonding**: Principle – types of adhesives, bonding methods – applications.	9
2	**Explosive welding:** principle and theory, equipment used, Process parameters and characteristics, weld joint design, Applications, advantages, and limitations. **Friction and Friction stir welding:** principle and theory – Process parameters and applications, Tools, and Metal flow. **Ultrasonic Welding:** principle, theory, and types – Welding environment, equipment used- Process parameters and characteristics, weld joint design and applications.	9

3	**Electron Beam Welding (EBW) -** principle and theory, Welding environment, equipment used- Process parameters and characteristics, weld joint design, Applications, advantages, and limitations. **Laser Beam Welding (LBW)** – Principle and theory, types of lasers, Process parameters and characteristics, Applications, advantages, and limitations. **Plasma Arc Welding (PAW) –**Theory – transferred arc and non-transferred arc techniques, equipment – applications.	**9**
4	**Magnetically Impelled Arc Butt (MIAB)**– principle and applications. Under water welding – wet land dry under water welding- set-up for underwater welding systems. **Brazing** – Principle – processes involved – torch brazing, furnace brazing, vacuum brazing, induction brazing – advantages and applications. **Micro-joining and nano-joining:** Introduction, theory, and applications.	**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	Summarise the Solid-state welding techniques and outline the physics of adhesive bonding.	**K2**
CO2	Compare and select between explosive welding, friction welding and ultrasonic welding based on the applications.	**K3**
CO3	Understand radiant energy welding technologies and explain the principle and working of EBW, LBW and PAW.	**K2**
CO4	Outline the modern joining technologies and select appropriate brazing technique to resolve modern metal joining problem.	**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
CO2	2	2	2	-	-	2	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	2
CO4	2	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	Advanced welding Processes	J. Norrish	Woodhead publishing	2006
2	Welding Processes and Technology	Parmar R. S	Khanna Publishers	1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Welding	R. W. Messler	John Wiley and Sons	1999
2	Metal Joining Manual	Schwartz M. M	McGraw-Hill Inc.	1979
3	Micro-joining and Nano-joining	Y. N. Zhou	Woodhead publishing	2008

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/112103244
2	https://nptel.ac.in/courses/112103244
3	https://nptel.ac.in/courses/112103244
4	https://nptel.ac.in/courses/112103244

SEMESTER S4

SUPPLY CHAIN AND LOGISTICS MANAGEMENT

Course Code	PEMET418	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 complexity and key issues in supply chain management.
2. Describe logistics networks, distribution planning, routing design and scheduling models.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Understanding the Supply chain, Achieving strategic fit in a supply chain. Supply chain drivers and metrics. Analysing and designing the supply chain network, factors affecting distribution network design, role of network design, models for designing regional network configuration. Impact of globalisation on supply chain networks.	9
2	Demand forecasting in supply chain, role of forecasting, components of forecasting, forecasting methods. Aggregate planning in supply chain, basic trade-offs in aggregate planning, linear programming in aggregate planning. Coordination in supply chain, impact of lack of coordination in the chain, obstacles to coordination, managerial levers to improve coordination.	9
3	Managing economies of scale in a supply chain: Cycle inventory, Aggregating Multiple Products in a Single Order & Quantity Discounts. Managing uncertainty in a Supply chain – Safety inventory: Factors affecting the optimal level of product availability. Impact of supply uncertainty on safety inventory. Impact of aggregation on safety inventory. Factors affecting the optimal level of Product availability.	9

4	Logistics management and its components. Modes of transportation and their performance Characteristics & Transportation infrastructure policies. Design options for a transportation and logistics network. Trade-offs in transportation design, Tailored transportation. Role of sustainability in a supply chain. Sustainability connected supply chain drivers.	**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	To analyse supply chains and design the supply chain network.	**K4**
CO2	To solve demand forecasting problems in the supply chain and enhance coordination in the network.	**K4**
CO3	To plan and manage inventories in the supply chain.	**K4**
CO4	To develop and plan transportation networks for supply chain considering sustainability also.	**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	2	2	1	2								
CO2	2	2		2						2		
CO3	2	2		2								
CO4	2	2	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	SupplyChain Management:Strategy, planning & Operation	Sunil Chopra and Dharam Vir Kalra	Pearson	7th edition, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Designing and managing the supply chain concepts, strategies, and cases studies	David Simchi- Levi, Edith Simchi-Levi	McGraw Hill	4th edition, 2022

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/110106045
2	https://nptel.ac.in/courses/110106045
3	https://nptel.ac.in/courses/110106045
4	https://nptel.ac.in/courses/110106045

SEMESTER S4

COMPUTER AIDED DESIGN AND MANUFACTURING

Course Code	**PEMUT415**	**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. The main objective of this course is to impart the application of computers in design, CNC programming, Cellular manufacturing, and Flexible manufacturing systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fundamentals of CAD/CAM**: Introduction to CAD/CAM, Historical Development, Industrial Look at CAD/CAM, Application of computers in design, Basics of geometric and solid modelling. Packages for CAD/CAM. Line drawing -Clipping, Bresenham's line algorithm, Solid modelling techniques- CSG and B-rep	9
2	**Geometric transformations in CAD:** 2D and 3D; transformations of geometric models like translation, scaling, rotation, reflection, homogeneous representations, concatenated representation. Simple problems **Standards for computer graphics-** Graphical Kernel System (GKS) — standards for exchange images- Open Graphics Library (OpenGL) — Data exchange standards — IGES, STEP, CALS etc.	9
3	**Introduction to NC systems and CNC** — Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure Drives and CNC controllers- 2D and 3D machining on CNC. **Introduction of Part Programming**—Functions of CNC, Features of CNC systems, Introduction of Part Programming - Simple turning and drilling programs using G codes and M codes	9

4	**Cellular Manufacturing and Flexible Manufacturing System –** Fundamentals of Cellular Manufacturing, Group Technology (GT), Part Families–Parts Classification and coding, Simple Problems in Opitz Part Coding system, Flexible Manufacturing System (FMS) – Components, Types, FMS work stations – FMS Application & Benefits.	**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	Gain a fundamental knowledge on Computer Aided Design methods	**K1**
CO2	Understand the geometric transformations and graphics standard in CAD	**K2**
CO3	Write part programme for CNC operations	**K3**
CO4	Understand the techniques of Cellular Manufacturing and FMS	**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		1										
CO2	1	2										
CO3	2	2							3			
CO4		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	CAD/CAM: Computer-Aided Design and Manufacturing	M. Groover	Pearson	2003
2	CAD/CAM Computer Aided Design and Manufacturing	E Zimmer and M Groover	Pearson	2014
3	CAD/CAM Principles and Applications	P N Rao	Tata McGraw-Hill	2015
4	CAD/CAM/CIM	P. Radhakrishnan	New Age International Publishers	2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mastering CAD/CAM	Ibrahim Zeid	Tata McGraw Hill	2006
2	Principles of Computer - Integrated Manufacturing	S.Kant Vajpayee	Prentice Hall of India, New Delh	1999
3	CNC Machining Handbook: Building, Programming, and Implementation	Alan Overby	McGraw-Hill Education TAB	2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/112/102/112102101/, https://onlinecourses.swayam2.ac.in/nou22_me08/preview,
2	https://archive.nptel.ac.in/courses/112/102/112102101/, https://onlinecourses.swayam2.ac.in/nou22_me08/preview,
3	https://archive.nptel.ac.in/courses/112/102/112102101/, https://onlinecourses.swayam2.ac.in/nou22_me08/preview,
4	https://archive.nptel.ac.in/courses/112/102/112102101/, https://onlinecourses.swayam2.ac.in/nou22_me08/preview,

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

(Common to All Branches)

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. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	**6**

2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	**6**
3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	**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 - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	**6**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject/ case Study	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 =18marks)**	• 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, national income and stock market.	**K2**
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and 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

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

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 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	**6**

	sustainable future.	

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 & Assessmen	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

MATERIALS TESTING LAB

Course Code	**PCMUL407**	**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. The experimental work involved in this laboratory should make the student understand the fundamental modes of loading of the structures and also make measurements of loads, displacements and strains. Relating these quantities, the student should be able to obtain the strength of the material and stiffness properties of structural elements.

Expt. No.	Experiments
1	Evaluate the tensile properties of a given material (mild steel, high-strength steel, or tor-steel) using a Universal Testing Machine (UTM) equipped with an extensometer.
2	Determination of compression strength of a given material (mild steel, tor-steel, or high-strength steel) using a Universal Testing Machine (UTM) equipped with an extensometer.
3	Determine the shear strength of a mild steel rod using a shear test.
4	Perform Brinell/Vickers/Rockwell hardness tests on a given material
5	Determine the torsional rigidity of mild steel/copper/brass rods.
6	Evaluate the flexural stiffness (flexural rigidity) of mild steel/copper/brass specimens using a three-point bend test on a Universal Testing Machine (UTM)
7	Determine the notch toughness of the material at room temperature using Izod and Charpy impact testing.
8	Investigate the effect of coil type (close-coiled vs. open-coiled) and arrangement (series vs. parallel) on spring stiffness.
9	Perform a bending test on a wooden beam to assess its load-carrying capacity.
10	Perform stress analysis using photo-elasticity.
11	Determination of Moment of inertia of flywheel
12	Determination of modulus of elasticity of a mild steel specimen using strain gauges.

13	Determination of coefficient of friction of steel on steel, steel on wood, steel on asbestos using inclined plane and sliding friction apparatus.
14	Non- destructive tests - Ultrasonic flaw detection test/ Magnetic crack detection test / Dye penetration test.
15	Measurement of angle using sine bar.
16	Measurements of Surface roughness, Using Tally Surf / Mechanical Comparator
17	Determination of tool signature using profile projector.
18	Measurement of threaded bolt/nut parameters using tool maker’s microscope.
19	To conduct an experiment to Verify Clerk Maxwell’s law of reciprocal deflection and determine young's Modulus of steel.

Note: 12 experiments are mandatory

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	Evaluate the mechanical properties of different materials under various loading conditions.	**K3**
CO2	Analyse the effect of design features on the performance of mechanical components.	**K4**
CO3	Utilize experimental techniques to determine material properties.	**K3**
CO4	Apply fundamental engineering principles to analyse the behaviour of structures under load.	**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					2			
CO2	2		3						2			
CO3	2			3	2				2			
CO4	3	2			2				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	Callister's Materials Science and Engineering	William D. Callister & David G. Rethwisch	Wiley	10th Ed (2018)
2	Mechanical Testing and Evaluation	Howard Kuhn; Dana Medlin	ASM International	Volume 8 (2000)
3	Metallography and Microstructures	George F. Vander Voort	ASM International	Volume 9 (2004)

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mechanics of Materials	James M. Gere and Barry J. Goodno	Cengage Learning	9th Ed (2022)
2	Introduction to Materials Science for Engineers	James F. Shackelford	Pearson	8th Ed (2022)

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_mm38/preview
2	https://archive.nptel.ac.in/courses/112/107/112107146/
3	https://archive.nptel.ac.in/courses/112/106/112106293/

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

MANUFACTURING TECHNOLOGY LAB

Course Code	**PCMEL408**	**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 understand the parts of various machine tools and impart hands-on experience on lathe, drilling, shaping, milling, grinding, tool and cutter grinding machines.
2. To study process parameters and practice arc and gas welding technologies.

Expt. No.	Experiments
1	Exercises on lathe: - Plain and step turning.
2	Exercises on lathe: - Ball & curve, and Taper turning.
3	Exercises on lathe: - Thread cutting.
4	Exercises on lathe: - Measurement of cutting forces in turning Process.
5	Exercises on shaping machine: - flat surfaces.
6	Exercises on shaping machine: - Grooves and key ways.
7	Exercises on drilling machine: - drilling, boring, reaming, taping and counter sinking etc.
8	Exercises on drilling machine: - Measurement of cutting forces in drilling process.
9	Exercises on cylindrical grinding machine: - Grinding of a plain cylindrical surface.
10	Exercises on surface grinding machine: - Grinding of a flat surface.
11	Exercises on tool and cutter grinding machine: - Grinding of a single-point cutting tool.
12	Exercises on milling machine: - Plane and pocket milling operations.
13	Exercises on milling machine: - Spur gear cutting operation.
14	Exercises on milling machine: - Measurement of cutting forces in milling process.
15	Exercises on arc welding: - butt welding and lap welding of M.S. sheets.

16	Exercises on gas welding: - butt welding and lap welding of M.S. sheets.
17	Study and preparation of program, simulation and exercise on CNC lathe:-turning, step turning, taper turning, thread cutting, ball and cup turning etc.
18	Study and preparation of program, simulation and exercise on CNC milling machine: - surface milling, pocket milling, contour milling etc.
19	Metallurgy: - Specimen preparation, etching & microscopic study of Steel, Cast iron and Brass and grain size measurement.
20	Exercises on part quality inspection using machine vision systems.
21	Exercises on industrial robots- manual and programmed path planning

A minimum of 12 sets of experiments are mandatory but both experiments mentioned for programming and experiments on CNC machines are mandatory.

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	The students can operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality.	**K3**
CO2	Apply cutting mechanics to metal machining based on cutting force and power consumption.	**K3**
CO3	Programming and manufacturing of complex profiles in CNC machines with high precision.	**K3**
CO4	Fabricate and assemble various metal components by welding and students will be able to visually examine their work and that of others for discontinuities and defects.	**K3**
CO5	Gain knowledge on the structure, properties, testing and applications of ferrous and non ferrous metals.	**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			1								
CO2	3			3								
CO3	3			2	3							
CO4	3			1								
CO5	3			1								

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	HMT	Tata McGraw Hill	2017
2	Workshop Technology Part I	W. A. J. Chapman	ELBS & Edward Arnold Publishers	1972
3	Numerical Control of Machine Tools	Yoram Koren	McGraw-Hill	2014
4	Production Technology	HMT	Tata McGraw Hill	2017

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

MECHANICAL ENGINEERING(AUTOMOBILE)

SEMESTER S5

AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS

Course Code	**PCMUT501**	**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 and Electronics Engineering	**Course Type**	Theory

Course Objectives:

1. Understand Fundamental Electrical components in automotives, automotive wiring and circuit diagrams.
2. Gain insights into automotive ignition systems, fuel injection types, and their applications.
3. Explore advanced electrical accessories, comfort systems, wiring systems, sensors, and actuators

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Automotive Electrical Systems-** Overview of automotive electrical systems- Automotive wiring and circuit diagrams. Earth return system- Automotive wires- Necessities of selecting wire gauges. **Automotive batteries-** Principle of lead acid battery & constructional details, Effect of temperature on electrolyte, Capacity Rating, Battery charging methods, Battery tests. Battery efficiency, Developments in storage batteries: Nickel metal hydride battery, Lithium-ion battery, Fuel cells, Ultra capacitors. **Charging systems and alternators-** Requirements of a charging system, DC Generators, Working and constructional details of Alternators (single and three phase), Rectification, voltage regulation, current regulation, Charging circuit for 3 phase alternators.	**11**
2	**Starting system:** Requirement of starter motor; Starter Motor types, construction and characteristics, Starter drive mechanisms, Starting circuit, Starter Switches, Starter relay.	**11**

	Ignition system: - Functions and requirements of an ignition system, Components of conventional ignition system, Ignition coil, Distributor, Battery ignition system and magneto ignition system, Ignition advance mechanisms, Spark plug- details, Spark plug heat flow, Platinum tipped spark plugs. Electronic ignition systems – Capacitive discharge ignition system, Distributor less ignition system, electronic spark advance.	
3	**Lighting and Signalling Systems: -** Types of headlights, headlight reflectors, headlight lenses, indicator lamp details, lighting circuit, projector headlights, Headlight aiming, Directional indicators. **Electrical Accessories: -** Horn and wiper mechanisms. Instrumentation: Speedometer, Fuel Level Indicator, Oil Pressure and Coolant Temperature Indicators, Display devices - LED, LCD, VFD. **Automotive safety systems: -** Airbag, Anti-lock brake systems, Traction control system, Tyre pressure monitoring system, Emergency brake assist system.	**11**
4	**Automotive electronics: -** Introduction to automotive electronics, Electronic dash board instruments, Vehicle cruise control, Vehicle navigation, Automatic air conditioner. **Sensors and Actuators: -** Sensors, working principle and its applications in Automobile - Pressure sensors, Temperature sensors, Position sensors, Lambda sensor, Air flow sensor, Wheel speed sensor, Knock sensor, Optical sensors. Actuators in automobiles: - Solenoids, Stepper motors, Relays, Piezoelectric. **Communication Networks in Vehicles –** Introduction to vehicle communication systems- CAN, LIN, MOST, and FlexRay.	**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 fundamental electrical Concepts in automotives, automotive wiring and circuit diagrams, automotive battery technologies, charging, automotive lighting, instrumentation, and starting systems.	**K2**
CO2	Gain Knowledge of functions and components in the Vehicle charging systems, ignition systems and starting systems	**K2**
CO3	Understand the characteristics of advanced electrical accessories, comfort systems and automotive lighting systems.	**K2**
CO4	Learn about Electronic control units, vehicle communication networks, various automotive sensors, and actuators.	**K2**

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							2
CO2	3	2			2							2
CO3	3	2			2							2
CO4	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	Automotive Electrical and Electronics	A K Babu	Khanna Book Publishing Company.	2016
2	Automobile Electrical and Electronics system.	Tom Denton	Elsevier Butterworth-Heinemann	5^{th} Edition 2017
3	Fundamentals of Automotive Electronics	V.A.W. Hillier	Stanley Thomas Publisher	2^{nd} Edition 2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Bosch Automotive Electrics and Automotive Electronics	Robert Bosch GmbH	Springer Fachmedien Wiesbaden	2013
2	Automotive Electrical Equipment.	Kohli.P.L	Tata McGraw-Hill Company Limited	2017
3	Automotive Electricity and Electronics	Al Santini	Cengage Learning	2012
4	Automotive Handbook	Robert Bosch	Bently Publishers	2011
5	Understanding automotive electronics	William B. Ribbens, Norman P. Mansour	Newnes	1992
6	Automotive Electrical HandBook	Jim Horner	Penguin	1987

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/Jd536TClZQo
2	https://nptel.ac.in/courses/113105102

SEMESTER S5

HEAT AND MASS TRANSFER

Course Code	**PCMUT502**	**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)	Thermodynamics and Thermal Systems (PCMUT402)	**Course Type**	Theory

Course Objectives:

1. Understand the basic modes of heat transfer and concepts of concepts of thermal conductivity, heat flux, and temperature gradients
2. Study the effectiveness, NTU (Number of Transfer Units) methods and the applications of Heat exchangers.
3. Study the basic theory and applications of mass transfer.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to heat transfer: -** Basic Modes of heat transfer- Conduction, Convection and Radiation. Thermal conductivity-effect of temperature on thermal conductivity- combined heat transfer mechanism-Engineering applications of Heat transfer. **Heat conduction: -** Fourier law, one dimensional steady state Conduction – plane wall, cylinder, sphere -concept of thermal resistance, critical radius, conduction with heat generation-Heat transfer from rectangular fins. Transient heat conduction-Lumped capacitance model, Concept of Heisler chart and Schmidt Plot.	**11**
2	**Heat transfer by Free and Forced Convection: -** Hydrodynamics and thermal boundary layers- Thickness of Boundary layer-displacement, Momentum and Energy thickness (description only). Newton's law of cooling- Reynold's number, Prandtl number, Nusselt number, Grashoff's number and Rayleigh's number- Dimensional analysis- Application of dimensional analysis to free and forced convection- empirical relations-	**11**

	problems using empirical relations in flow over a flat plate, cylinder, vertical wall etc.	
3	**Boiling and Condensation heat transfer phenomena**: Boiling Regimes and the Boiling Curve, Bubble shape, size, growth and collapse-Simplified relations for boiling heat transfer, Boiling and condensation heat transfer phenomena, film and dropwise condensation. **Introduction to heat exchangers**-Types of heat exchangers-the overall heat transfer coefficient-Fouling factor-LMTD analysis of heat exchangers effectiveness- NTU method-Analysis of variable properties-compact heat exchangers-heat exchanger design considerations.	**11**
4	**Heat transfer by radiation:** Nature of thermal radiation-Radiation properties, Black body radiation, Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; Gray body Radiation shape factors, heat exchange between black/gray surfaces -Infinite parallel planes **Mass Transfer: -** Introduction to mass transfer, Modes of mass transfer, Molecular diffusion in fluids, Steady state molecular diffusion in fluids under stagnant and laminar flow conditions, Fick's law of diffusion, Types of solid diffusion- mass transfer coefficients in laminar and turbulent flows, Equimolar counter diffusion, Correlation for convective mass transfer coefficient for single cylinder, Theories of mass transfer, Overall mass transfer coefficients.	**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	Study the basic principles of heat transfer, governing equations and applications of conduction, convection, and radiation.	**K2**
CO2	Understand the concept, equations, effectiveness and applications of Heat exchangers.	**K2**
CO3	Understand the basic concepts, principles, governing equations, and applications of mass transfer	**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								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	A Textbook of Heat and Mass Transfer	R K Rajput	S. Chand Publishing	7th edition 2019
2	Fundamentals of Heat and Mass Transfer	C. P. Kothandaraman	New Age International	3rd edition 2016
3	Heat and Mass Transfer	P K Nag	Tata McGraw-Hill Education	3rd edition 2011
4	Heat and Mass Transfer Data Book	C. P. Kothandaraman S Subramanyan	New Age International Publishers	5th edition 2006

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Heat and Mass Transfer	Frank P Incropera David P Dewitt	Wiley India	5th edition 2009
2	Fundamentals of Heat and Mass Transfer	Theodore L Bergman Adrienne S Lavine	Wiley	7th Edition 2011
3	Heat and Mass Transfer	Hans Dieter Baehr, Karl Stephan	Springer Berlin Heidelberg	2006

SEMESTER S5

ELECTRIC VEHICLES-DRIVES AND CONTROL

Course Code	**PCMUT503**	**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 Electrical and Electronics	**Course Type**	Theory

Course Objectives:

1. To introduce configuration of EV
2. To select appropriate motor and control for EV application

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Electric Vehicles- Social and environmental importance of electric vehicle- Classification based on propulsion system. Electric components used in electric vehicles. Block diagram of electric drive, classification of electric motor drives for EV. Role of power electronics converters in electric propulsion system -DC-DC Converters and DC-AC Converters (Basic Principles only)	**9**
2	DC motors-Principle of operation, Back emf, significance of back emf, voltage equation, power equation, types. Torque and speed equations- torque speed characteristics- Speed control of dc motor- Pulse width modulation control of dc motor. Principles of starting, losses and efficiency - load test. Regenerative braking in DC motors.	**9**
3	Three phase induction motors- slip ring and squirrel cage types- principle of operation – rotating magnetic field- torque slip characteristics- no load and blocked rotor tests. methods of starting – direct online – auto transformer starting. Speed control of induction motors -v/f control, FOC Control, field weakening control.	**9**

4	Principles of operation of synchronous motors- methods of starting-working of Permanent Magnet synchronous motor. BLDC - Brushless DC Motor-Construction, working principle, speed-torque characteristics. Direct Torque Control Drive of BLDC Motor for EV Application Switched Reluctance Motor- Working principle, speed-torque characteristics-microprocessor based control for SRM	**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)**	• 2 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. • Each question carries 9 marks. **(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	Familarise with the electrical components in EV	**K2**
CO2	Describe the basic concepts of different types of electrical machines used in EV and its performance	**K2**
CO3	Understand the different methods of starting D.C motors and induction motors.	**K2**
CO4	Illustrate the various speed control techniques of induction motors	**K3**
CO5	Analyse the operation of electric motor drives and discuss methods for controlling them	**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	2	1										
CO2	3	2	1									
CO3	3	1										
CO4	3	2										
CO5	3	3	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	Electric and Hybrid Vehicles- Design Fundamentals	Iqbal Husain	CRC Press	2003
2	Fundamentals of Electric Drives	G. K. Dubey	Narosa	2^{nd} edition,2003
3	Electric Drives Concepts and Applications	Vedam Subrahmanyam	MC Graw Hill	2^{nd} edition,2011
4	Electric Motor Drives: Modeling, Analysis, and Control	R Krishnan	Prentice Hall	2001

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Power Electronics	Dr. P. S. Bimbhra	Khanna publishers	5th edition, 2012.
2	Electric Vehicle Technology Explained	James Larminie, John Lowry	Wiley	2nd edition,2003
3	Power Electronics, Devices, Circuits and Applications	Muhammad H.Rashid	Pearson	3rd edition, 2014
4	Principles of Electrical and Electronics	Mehta V. K. and R. Mehta	S. Chand & Company Ltd	2nd edition ,2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/108/103/108103009/
2	https://archive.nptel.ac.in/courses/108/106/108106170/
3	https://archive.nptel.ac.in/courses/108/104/108104140/
4	https://onlinecourses.nptel.ac.in/noc22_ee53 https://onlinecourses.nptel.ac.in/noc21_ee112

SEMESTER S5

MECHANICS OF MACHINERY

Course Code	PBMUT504	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 kinematics of different mechanism
2. To understand the motion resulting from a specified set of linkages and to synthesis the mechanism.
3. To understand and to design of cam mechanisms for specified output motions.
4. To understand the basic concepts of toothed gearing and kinematics of gear trains

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Degrees of Freedom, Mobility analysis - Kutzbach and Grubler's criterion, Grashof's criterion (3hrs) Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain, Slider Crank Mechanisms, Double slider crank Mechanisms and their Inversions, (3) Displacement, velocity analysis– relative velocity. Instantaneous centre - Acceleration analysis of Planar 4 link mechanisms – Concept of Coriolis acceleration (6)	12
2	**Cams** - Types of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion- Graphical cam profile synthesis (6) **Gears** – Classification- terminology of spur gears – law of gearing - tooth profiles- contact ratio - interference - backlash - gear standardization –interchangeability. Gear trains - simple and compound gear trains - planetary gear trains.	12

	Tabulation method (6)	
3	**Kinematic synthesis of planar mechanisms** - type, number and dimensional synthesis –Definitions of Motion, Path and Function generation, precision points, Chebychev spacing, Freudenstein's equation (4) **Balancing of Rotating masses**-static and dynamic balancing - balancing of masses rotating in several planes (4) **Balancing of Reciprocating masses-** balancing of multicylinder in line engines (2)	**10**
4	**Gyroscope-** effects on the stability of sea vessels and air crafts (Problem analysis), concepts of gyroscopic effects on two wheelers and four wheelers (4) **Vibrations-** free and forced vibration of single degree freedom systems, effect of damping: vibration isolation; resonance; critical speeds of shafts (6)	**10**

Suggestion on Project Topics

1. Computer Programs to analyse and synthesis mechanisms.
2. Synthesis and Fabricate Simple mechanisms
3. Create simple models for mechanisms and demonstrate its motion.
4. Fabrication of gears and cams (FAB lab)

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Exam-1	Internal Exam-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	Calculate degrees of freedom of mechanisms and interpret their inversions.	**K3**
CO2	Perform velocity and acceleration analysis of various planar mechanisms	**K4**
CO3	Solve the problem on cams and gear drives, including selection depending on requirement.	**K3**
CO4	Construct a mechanism for a specified output motion	**K4**
CO5	Create proto type of various mechanisms.	**K6**

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										
CO2	3	3										
CO3	3	2										
CO4	3	3	2									
CO5	3	3	3									

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Theory of Machines and Mechanisms	Ballaney P. L.	Khanna Publishers	2005
2	Theory of Machines	S. S. Rattan	Tata McGraw Hill	2009
3	Theory of Mechanisms and Machines	A Ghosh	East West	2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Kinematics and Dynamics of Machinery	C. E. Wilson, P. Sadler	Pearson Education	2005
2	Theory of Machines and Mechanisms	J. E. Shigley, J. J. Uicker	McGraw Hill	2010
3	Machines and Mechanisms Applied Kinematic Analysis	D. H. Myskza	Pearson Education	2013
4	Kinematics and Dynamics of Machinery	Norton	Tata McGraw Hill	2009

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	www.youtube.com for mechanism animations
2	https://archive.nptel.ac.in/courses/112/105/112105268/
3	https://archive.nptel.ac.in/courses/112/105/112105268/
4	https://archive.nptel.ac.in/courses/112/105/112105268/ (https://www.youtube.com/watch?v=oQrcPiQuCHI)

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 S5

COMPUTATIONAL FLUID DYNAMICS

Course Code	**PEMET521**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30Min..
Prerequisites (if any)	Fluid Mechanics and Machinery	**Course Type**	Theory

Course Objectives:

Introduce students to

1. The finite difference methods and finite volume methods as a means of solving different types of differential equations that arise in fluid dynamics and heat transfer.
2. The fundamentals of numerical analysis, ordinary differential equations and partial differential equations related to fluid mechanics and heat transfer
3. The error control and stability considerations associated with numerical solutions.
4. A class of methods used in computational fluid dynamics for numerically solving the Navier-Stokes equations for 2D incompressible flows.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Computational Fluid Dynamics, Governing Equations of fluid flow and heat transfer, Conservative form of Navier-Stokes equation, General transport equation. Physical and mathematical classifications of partial differential equations. Elliptic, parabolic and hyperbolic equations, Comparison of experimental, theoretical and numerical approaches; applications of CFD.	**9**
2	Discretization-converting derivatives to their finite difference forms-Taylor's series approach and polynomial fitting approach. Central difference, backward difference, and forward difference of first and second order derivatives. Solution of partial differential equations using finite difference equations. Discretization error, truncation error, round off error. Consistency and numerical stability. Iterative convergence,	**9**

	condition for convergence, rate of convergence. Termination of iteration. Boundary and Initial conditions	
3	Introduction to finite volume method. Finite volume method for steady one–dimensional conduction problems. one–dimensional transient heat conduction problems -explicit, implicit, Crank- Nicholson schemes, under and over relaxations, handling of boundary conditions; dealing with Dirichlet, Neumann, and Robins type boundary conditions; two-dimensional steady state conduction problems; point-by-point and line-by-line method of solution; tri-diagonal matrix algorithm.	**9**
4	Finite volume method for steady-state diffusion and convection-diffusion problems; Central difference and Upwind schemes for convection and diffusion problems. Two dimensional incompressible viscous flows. Staggered grid. Pressure correction methods. Solution algorithm for pressure-velocity coupling in steady flows- SIMPLE algorithm to solve Navier - Stokes equations. Computer graphics techniques to present CFD results.	**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	To understand the governing equations of fluid flow and heat transfer.	**K2**
CO2	To apply finite difference methods to simple partial differential equations	**K3**
CO3	To demonstrate the use of finite volume method for simple 1D/2D problems	**K3**
CO4	To understand different solution techniques for convection diffusion equation	**K2**
CO5	To apply the knowledge of CFD to interpret the graphical results	**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	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-
CO4	2	2	-	2	-	-	-	-	-	-	-	-
CO5	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	Computational Fluid Dynamics	John D Anderson Jr	McGraw-Hill Book Company	2012
2	Numerical Heat Transfer and Fluid Flow	S V Patankar,	McGraw-Hill	2017
3	An Introduction to Computational Fluid Dynamics: The Finite Volume Method	H. Versteeg, W. Malalasekera	Pearson	2nd, 2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to computational fluid dynamics	Anil W. Date	Cambridge University Press	2005
2	Introductory methods to numerical analysis	S SSastry	PHI learing Private Ltd.	2012
3	Heat transfer	S P Venkatesh	Ane books Pvt Ltd	2009

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/112105045
2	https://onlinecourses.nptel.ac.in/noc20_me64/preview
3	https://nptel.ac.in/courses/112105045 https://onlinecourses.nptel.ac.in/noc21_me126/preview
4	https://onlinecourses.nptel.ac.in/noc21_me126/preview https://onlinecourses.nptel.ac.in/noc20_me64/preview

SEMESTER S5

AUTOMOTIVE POLLUTION AND CONTROL

Course Code	**PEMUT522**	**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	Automotive Systems (PCMUT302) Automotive Engines and Transmission (PBMUT404)	**Course Type**	Program Elective

Course Objectives:

1. To give an overview on the emission standards and automotive pollution measurement techniques and its control mechanisms.
2. To understand the advanced emission reduction technologies used in pollution control.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to automotive Pollutants: -** Sources, formation, Types, Impact of pollution on environment and human. **Emission standards & regulations** –Overview of global and regional emission standards- Euro, EPA, Bharath. US, European union standards, & Indian standards. Compliance with standards, certification, **Noise pollution in automobiles**: **-** Sources, types, Measurements, Noise control techniques.	**9**
2	**Pollutant formation:** – Formation of HC, PM, NOx & CO in SI and CI engines, oxidation of soot, role of soot inhibitors, aldehydes, ketones, alcohols, and organic acids. Factors influencing formation of pollutants. **Fuel quality**: - Impact of fuel quality, fuel additives, role of fuel additives in emission reduction, Emission characteristics of alternate fuels - CNG, LNG, LPG, Biofuels, hydrogen in emission.	**9**
3	**Emission measurement techniques and instruments: -** Procedure of emission measurement, light heavy-duty vehicles, two wheelers. Crankcase, evaporative, refuelling and on-road emissions. Laboratory testing	**9**

	procedures, NDIR analysers, FID, Chemiluminescence analysers. **Emission Control Technologies:** - Gasoline fuelled vehicles, Air fuel ratio, electronic control. Catalytic convertors – two-way and three-way convertors, catalytic wear, and poisoning. Diesel fuelled vehicles, Diesel Particulate Filter, exhaust after treatment, EGR, DEF, Crankcase emission and control - evaporative emission and control – fuel dispensing and distribution emissions and control, Selective catalytic reduction. Lean Nox Traps.	
4	**Engine modification for effective emission control: -** Advanced combustion technologies. HCCI, GDI. VVT, Turbocharging and downsizing, advanced fuel injection systems. **On Board Diagnostics: -** Role of OBD in emission control, DTC, and its interpretations. **Vehicle replacement and retrofit programs: -** Scrappage and relocation – replacement – retrofit program. Intelligent vehicle- highway 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 Sources, Impact, and mechanisms of pollutant formation in Automotives	**K2**
CO2	Understand the working principles and applications of various emission control technologies in SI, CI and Alternate fuel engines	**K2**
CO3	Familiarize with emission measurement instruments and techniques including laboratory testing procedures	**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	2										2
CO3	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	Automotive Fuel and Emissions Control Systems	James D. Halderman	Pearson,	2012
2	Controlling automobile air pollution	Virginia McConnell	Taylor & Francis	2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cleaner Cars: - The History and Technology of Emission Control Since the 1960s	J. Robert Mondt	Society of Automotive Engineers	2000
2	Automobile Pollution, Concerns, Priorities, and Challenges	Shyam Kishor Agarwal	Ashish Publishing House	1991
3	Air Pollution from Motor Vehicles Standards and Technologies for Controlling Emissions.	Asif Faiz, Christopher S. Weaver, Michael P. Walsh	World bank	1996
4	Air Pollution, the Automobile, and Public Health	Ann Y. Watson, Sc.D., Richard R. Bates, M.D., Donald Kennedy, Health Effects Institute	National Academies Press	1988

SEMESTER S5

TRACTORS, FARM EQUIPMENTS AND SPECIAL TYPES OF VEHICLES

Course Code	PEMUT523	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)	PBMUT404, PCMUT303	Course Type	Theory

Course Objectives:

1. To familiarize the working and construction of various types of tractors
2. To understand the constructional features of farm equipment
3. To understand the construction details and working of special type of vehicles and cranes

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Tractors and tractors units-** General description of tractors: classification of tractors, Components of tractor. Applications of tractors, rating of tractors, wheeled and crawler tractor. Layout of wheeled and crawler tractors, crawler details. Power transmission, steering system, brakes and braking system, wheels, rims, tyres and accessories of wheeled tractors and crawler tractors	9
2	**Introduction to Farm equipment-** Introduction to harvesting - Principles and types of cutting mechanisms. Study of harvesting operation– harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working. Introduction to threshing systems – manual and mechanical systems. Types of threshers- tangential and axial, their constructional details and cleaning systems	9
3	**Construction details and working of special type of vehicles-** Multi axle vehicles- A- Train, B- Train, C- Train Road roller, Bulldozers, cable and hydraulic dozers. Crawler track, running and steering gears. Dump trucks, Loaders, single bucket, multi bucket and rotary types,	9

	Scrapers, elevating graders, self-powered scrapers and graders, road rollers	
4	Construction and operational aspects of mobile cranes, elevators/ Man lifters, Fork Lifters, Shovels and Ditchers: Capacity of shovels. Power shovel, revolving and stripper shovels - draglines - ditchers -	**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 design and functionality of tractor	**K2**
CO2	Comprehend Farm Equipment and Harvesting Techniques	**K2**
CO3	Understand Special Types of Construction Vehicles	**K2**
CO4	Explore Construction and Industrial Equipment	**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
CO2	2				1					2		1
CO3	2				1					2		1
CO4	2	1			1					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	Farm Machinery – An Approach.	Jain S. C., and Grace Philip.	Standard Publishers Distributors., New Delhi	2012.
2	Principles of Agricultural Engineering Vol. I.	Ojha, T. P. and Michael, A. M.	Jain Brothers, New Delhi	2011.
3	Moving the earth	Herbert Nicholas, David Day	McGraw Hill Edn.,	2010
4	Construction equipment and its management	S.C. Sharma	Khanna Publishers	2019

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Tractors and Automobiles	Rodhiev and Rodhiev	MIR. Publishers, Moscow	1987
2	Farm Machines And Equipment	Nakra C.P	Dhanpat Rai Publishing Company (P) Ltd-New Delhi	2003

SEMESTER S5

ADDITIVE MANUFACTURING

Course Code	**PEMET524**	**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 demonstrate appropriate level of understanding on principles of additive manufacturing
2. To understand the different additive manufacturing technologies.
3. To choose appropriate materials for additive manufacturing processes
4. To design prototypes by identifying suitable process with optimum process parameters

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Additive Manufacturing (AM)** –Basic principle of AM-Procedure of product development in AM process chain. Classification of additive manufacturing processes, Basic concept, Digitization techniques, Benefits and challenges in AM. **Data processing for AM-** CAD model preparation, Part orientation and support generation, Slicing methods, Tool path generation, STL Formats. Demonstration of slicing software packages.	**8**
2	**Common AM technologies:** Principle, materials, process parameters, advantages and applications of: Stereo Lithography (SLA), Digital Light Processing (DLP), Continuous Liquid Interface Production (CLIP), Laminated Object Manufacturing (LOM), Ultrasonic AM (UAM), 3D printing, Binder Jetting, Material Jetting, Fused Deposition Modelling (FDM), Direct Ink Writing (DIW).	**10**
3	**Common AM technologies:** Principle, materials, process parameters, advantages and applications of: Selective Laser Sintering (SLS),	**10**

	Selection Laser Melting (SLM), Electron Beam Melting (EBM), Wire Arc Additive Manufacturing (WAAM), Laser Engineering Net Shaping(LENS).	
4	**Design for AM (DFAM)** AM unique capabilities, DFAM concepts and objectives, Design freedom and synthesis methods. **Applications for AM** Applications: Prototyping, Industrial tooling, Aerospace, Automobile, Medical etc.	**8**

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 of AM from conventional manufacturing systems.	**K2**
CO2	Understand the data processing techniques in AM process	**K2**
CO3	Understand the principles of AM processes.	**K2**
CO4	Create components using AM process.	**K6**
CO5	Understand the key aspects in design a product using AM.	**K2**
CO6	Understand the application of AM in industries	**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	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2		3	-	-	-	-	-	-	-
CO3	2		2	-	-	-	-	-	-	-	-	-
CO4	2	-	3	-	3	-	-	-	-	-	-	-
CO5	2	2	2	2	2	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	Additive Manufacturing Technologies-3D Printing, Rapid Prototyping, and Direct Digital Manufacturing.	Gibson l D. W. Rosen l and B. Stucker	Springer	Second Edition, 2015
2	Rapid prototyping: Principles and applications	Chua, C.K., Leong K.F. and Lim C.S.	World Scientific Publishers	Third edition, 2010.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Rapid Manufacturing The Technologies and Applications of Rapid Prototyping and Rapid Tooling	D.T. Pham and S.S. Dimov	Springer London Ltd	Softcover reprint of the original 1st ed. 2001, 2011
2	Additive Manufacturing: Principles, technologies and Application	C.P. Paul, A.N. Jinoop	McGraw Hill	First Edition, 2021
3	Additive Manufacturing Technologies	S. Shiva, Anuj K. Shukla	Wiley	First Edition, 2024
4	Additive Manufacturing: Fundamentals and Advancements	Manu Srivastava, Sandeep Rathee, Sachin Maheshwari	CRC Press	First Edition, 2019

Video Links (NPTEL, SWAYAM…)	
NPTEL	NOC: Fundamentals of Additive Manufacturing Technologies, IIT Guwahati by Prof. Sajan Kapil Link: https://nptel.ac.in/courses/112103306

SEMESTER S5

AUTOMOTIVE STANDARDS AND REGULATIONS

Course Code	**PEMUT526**	**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**	Program Elective

Course Objectives:

1. Understand the national and international regulatory bodies and learn the automotive regulations and standards.
2. To Learn about testing protocols and safety rating systems of automobiles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to automotive industry regulations**. Importance of standards in the automotive sector, Automotive Regulatory bodies, Role of regulatory bodies. Vehicle safety standards- Federal motor vehicle safety standards, Euro NCAP and global NCAP testing and rating- description, recent improvements. Car crashworthiness standards, role of National Highway Traffic Safety Administration, Crashworthiness Tests-Component tests, Sled tests, Full-scale barrier impact tests. Common safety standards for type approval of Passenger cars, Environmental standards – Noise, Emission, fuel consumption, exhaust losses.	**9**
2	**Major Passive Safety Standards in automobiles: -** Electronic Stability Control (ESC), Anti-Lock Braking System (ABS), Airbags for driver and front passenger, Reverse parking sensors and cameras, Speed alert system, Safety belts, anchorages, and head restrains, Seat Belt Reminder, Child Safety, Driver field vision, safety glass, side door impacts. Safety regulations for ADAS technologies, Ethical and legal considerations in Autonomous driving. Automotive lighting standards- reflectors, lamps, signalling devices, position	**9**

	of indicators, headlight height, spotlights,	
3	**Automotive Emission standards and regulations**: **-** Emission standards and regulations in India, International standards, U.S. Environmental Protection Agency (EPA) standards, California Air Resources Board (CARB) standards, European Emission Standards, Estimation of vehicle emissions – in light duty vehicles, and Heavy-duty vehicles. Crankcase emission, Evaporative emission, Refuelling emissions. Fuel options for controlling emissions- Gasoline engines- Lead and octane number, Olefins, Aromatic hydrocarbons. Diesel engines – cetene number, Alternate fuels – LNG, CNG, Biofuels.	**9**
4	**National Highway Traffic Safety Administration vehicle safety regulations**: **-** Average fuel economy standards, CAFÉ Standards, Technologies for improving fuel efficiency, Manufacturing and Quality Standards in automotives - ISO 9001 and TS 16949 for quality management systems, Standards for automotive parts and components- Automotive bulbs, Bus body building, Lubrication oils, Piston, and piston rings. Standards for automotive materials – metals, plastics, glass, composites. Major vehicle testing protocols.	**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 national and international regulatory bodies and the frameworks of the automotive industry.	**K2**
CO2	Understand the key points in the Major Passive Safety Standards in automobiles	**K2**
CO3	Study the emission standards and norms in automotives	**K2**
CO4	Gain knowledge on the standards and regulations for automotive components and systems.	**K2**

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
CO2	3	1										2
CO3	3	1										2
CO4	3	1										2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Handbook on Automobile & Allied Products	National Project Consultancy Board	NIIR Project Consultancy Services	2nd Edition 2013
2	Automotive Quality Systems Handbook	David Hoyle	Elsevier Butterworth Heinemann	2nd Edition 2005
3	Indian Emission Norms and Practices	Mr P. Vignesh, Dr. A.R. Pradeep Kumar, Dr. N. Shankar Ganesh	Bohr publications	2021

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Automotive Technology Principles and Practices.	Kirk T. VanGelder	Jones & Bartlett Learning	3rd edition 2022
2	The Vision Zero Handbook Theory, Technology and Management for a Zero Casualty Policy	Claes Tingvall, Karin Edvardsson Bjornberg, Matts-Åke Belin, Sven Ove Hansson	Springer International Publishing	2022
3	The Intelligent Safety of Automobile	Jianqiang Wang, Bingbing Nie, Hong Wang	Springer Nature Singapore	2022
4	Effectiveness and impact of corporate average fuel economy standards	CAFÉ standards report	Transportation research board, National Research council	2002

SEMESTER S5

INSTRUMENTATION AND CONTROL SYSTEMS

Course Code	**PEMET525**	**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 the basic principles of instrumentation.
2. Familiarize with various types of sensors and transducers used for measuring physical quantities
3. Gain knowledge of the fundamental concepts of control systems including open-loop and closed-loop systems.
4. Learn about system dynamics, mathematical modelling of physical systems and stability analysis of LTI systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Industrial measurement systems – different types of industrial variables and measurement systems elements. Sensors– Sensor components - Resistive sensors - Inductive sensors - Capacitive sensors - Thermoelectric sensors - Piezoelectric sensors. Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge etc.	9
2	Industrial signal conditioning systems- Operational amplifiers - Amplifier circuits with ideal operational amplifiers - Current-to voltage converters - Inverting voltage amplifiers - Non-inverting voltage amplifiers - Differential amplifiers -Instrumentation amplifiers . Filters – Passive filters - First and second order RC-filters - Low-pass first-order RC-filter – High pass first-order RC-filter – Band pass filters , A/D converters for industrial measurements systems. Data Acquisition Systems(DAS) –Objectives of	9

	DAS.	
3	System Modeling- Open loop and closed loop control systems ,Transfer function of LTI systems- Electrical, translational and rotational systems – Force voltage and force current analogy Block diagram representation - block diagram reduction, Signal flow graph - Mason's gain formula. Control system components: Transfer functions of DC and AC servo motors– Control applications of Tacho generator and Stepper motor. Characteristic equation of Closed loop systems. Controllers- P, PI, and PID controllers.	**9**
4	Time domain analysis of control systems: Time domain specifications, Impulse and Step responses of first order and second order systems. Error analysis: Steady state error analysis - static error coefficients of type 0,1,2 systems. Stability Analysis: Concept of stability— Routh's stability criterion, Root locus method. Frequency Domain Analysis: Frequency Domain Specifications, Stability in Frequency Domain, Gain Margin, Phase Margin, Bode Plot, Polar Plot, Nyquist Plot.	**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	To get basic knowledge about industrial measurement system and different elements involved in it.	**K2**
CO2	Acquire knowledge about sensors and transducers for different industrial variables	**K4**
CO3	Acquire knowledge about signal conditional circuits like amplifiers, filters, ADC, etc. for working industrial measurement systems	**K4**
CO4	To describe the role of various control blocks and components in feedback systems	**K3**
CO5	To analyse the time domain responses of the linear systems and apply Root locus technique to assess the performance.	**K4**
CO6	Analyse the stability of the given LTI system	**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	C	1	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	3
CO5	3	3	3	-	2	-	-	-	-	-	-	3
CO6	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 Instrumentation	K Krishnaswamy	New Age International Publishers, New Delhi	2003
2	Measurement systems applications and design	Ernest O. Doebelin	McGraw- Hill Publishing Company	1990
3	Control Systems Engineering	Nise N.S.	Wiley Eastern	6/e
4	Modern Control Engineering	Ogata K	Prentice Hall of India.	5/e
5	Control Systems	K R Varmah	Tata McGrawHill Tata McGrawHill	2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Principles of Industrial Instrumentation	Patranabis D	McGraw-Hill Education	3rd Edition,2017
2	Industrial Instrumentation and Control	Singh, S.K	Tata McGraw-Hill Education	2009
3	Control Systems Principles and Design	Gopal M	Tata McGraw Hill	, 4/e
4	Automatic Control Systems	Kuo B. C	Prentice Hall of India	7/e

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/108105064
2	https://nptel.ac.in/courses/108105062
3	https://nptel.ac.in/courses/107106081
4	https://nptel.ac.in/courses/107106081

SEMESTER S5

COMPUTER AIDED DESIGN AND ANALYSIS LAB

Course Code	**PCMUL507**	**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. Learn to design and assemble mechanical components using software like Catia, Inventor, SolidWorks, Creo and Fusion 360, creating detailed 3D models and accurate 2D drawings.
2. Gain proficiency in using FEA software to analyse structures like axial bars, beams, and trusses to determine stress, deformation, and support reactions.
3. Learn to use FEA software for steady-state and transient heat transfer analyses, understanding temperature distribution and heat transfer rates in materials like plates and fins.
4. Develop skills in using CFD software to improve flow device performance by analysing and optimizing airflow in components like air intake manifolds.

Expt. No.	Experiments
PART-1	
1	Creating assembly models and drafting of Socket and spigot joint
2	Creating assembly models and drafting of Knuckle Join
3	Creating assembly models and drafting of Rigid flange couplings
4	Creating assembly models and drafting of Flexible coupling,
5	Creating assembly models and drafting of Plummer block
6	Creating assembly models and drafting of Single plate clutch
7	Creating assembly models and drafting of Cone friction clutch
8	Creating assembly models and drafting of Diesel Engine Piston
9	Creating assembly models and drafting of Petrol Engine Piston
10	Creating assembly models and drafting of Screw jack
11	Creating assembly models and drafting of Tail Stock
PART-2	

1	Perform a structural analysis of an axial bar with varying cross-sectional areas under axial load using FEA software to determine the stress distribution, strain distribution, and total deformation
2	Perform a structural analysis of a truss using FEA software to determine the force in each member, identify if the members are in tension or compression, and calculate the support reactions
3	Perform the structural analysis of a thin plate (plane stress case) subjected to in plane loads
4	Perform the modal analysis of a cantilever beam
5	Solve a steady-state heat conduction problem using FEA software to determine the temperature distribution within a solid material.
6	Perform a flow analysis to improve the design of an air intake manifold for a pneumatic device by analyzing flow separations and recirculation zones using flow analysis software
Note: - Out of 11 exercises in PART-1, 8 should be given as exercises in the lab sessions and Out of 6 exercises in PART-2, 4 exercises should be given in the lab sessions. The rest of the exercises are optional	

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	Gain working knowledge in Computer Aided Design and modelling procedures.	**K2**
CO2	Gain knowledge in creating and assembling machine elements.	**K3**
CO3	Gain working knowledge in Finite Element Analysis	**K4**
CO4	Solve simple structural, heat and fluid flow problems using standard software	**K4**

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							2		1
CO2	3		2							3		1
CO3	3	3	2							3		1
CO4	3	1	2							3		1

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 Design with SolidWorks	David C. Planchard and Marie P. Planchard	SDC Publication	2019
2	Creo Parametric 6.0 for Engineers and Designers	Prof. Sham Tickoo	BPB Publications	2019
3	Finite Element Analysis: Theory and Application with ANSYS	Saeed Moaveni	Pearson	2011
4	Fundamentals of Heat and Mass Transfer	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt	John Wiley & Sons	2012
5	Introduction to Computational Fluid Dynamics	Anil W Date	Cambridge University Press	2005
6	Manuals of software such as CatiaV and UG NX	Respective OEM	Latest Manuals of software such as CatiaV and UG NX	

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

THERMAL AND INTERNAL COMBUSTION ENGINES LAB

Course Code	**PCMUL508**	**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	PCMUT403	**Course Type**	Lab

Course Objectives:

1. To understand the principles and components of internal combustion engines, as well as their behaviour under different load conditions, thereby enhancing theoretical knowledge with practical insights.
2. To obtain comprehensive practical skills and theoretical knowledge necessary to analyse, evaluate, and optimize the performance of different thermal systems.

Expt. No.	Experiments
1	Study of 4 stroke and 2 stroke IC engine, components using cut section models.
2	Valve timing diagram of a 4-stroke petrol/diesel engine
3	Port timing diagram of a 2-stroke engine.
4	Performance test on a 4-stroke diesel engine.
5	Performance test on single cylinder 2 – stroke petrol engine
6	Heat balance test on Internal Combustion engine.
7	Morse test on multi cylinder petrol engine.
8	Retardation test on single cylinder diesel engine.
9	Economic speed test on 4 stoke Petrol engine.
10	Determination of optimum cooling water temperature for maximum thermal efficiency.
11	Determination of viscosity using Redwood Viscometer.
12	Performance test on Multistage reciprocating air compressor.
13	Performance test on Rotary Compressor.
14	Performance test on centrifugal blower.
15	Determination of flash and fire point.
16	Determination of COP of vapour compression refrigeration system.
17	Determination of Effectiveness and LMTD of Parallel flow, Counter flow heat exchangers.

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 comprehend the various systems and subsystems integral to both diesel and petrol engines.	**K2**
CO2	Conduct performance tests on IC engines, focusing on operational characteristics under varying load conditions, preparation of heat balance determination of FP etc.	**K3**
CO3	Understand the performance characteristics of air compressors and blowers and the effect of operational parameters on efficiency.	**K2**
CO4	Determine flash point, fire point and viscosity of different oils.	**K3**
CO5	Determine the coefficient of performance of vapor compression refrigeration 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			2					2	2		2
CO2	3			2					2	2		2
CO3	3			2					2	2		2
CO4	3			2					2	2		2
CO5	3			2					2	2		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	Heat Transfer a Practical Approach	Yunus A. Cengel	Tata McGraw-Hill Education	4th Edition, 2012.
2	Fundamentals of Heat and Mass Transfer	Kothandaraman C.P	New Age International, New Delhi.	2006
3	Fundamentals of IC engines,	V. Ganesan	Tata McGraw-Hill	4, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Heat and Mass Transfer	Frank P. Incropera and David P. Dewitt	John Wiley and sons	2011
2	Heat transfer	Holman J.P	Mc Graw-Hill	10th. Ed., 2009
3	An Introduction to Combustion: Concepts and Applications,	Stephen R Turns	McGraw-Hill	3,2011

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

MECHANICAL ENGINEERING

(AUTOMOBILE)

SEMESTER S6

DESIGN OF AUTOMOTIVE COMPONENTS

Course Code	PCMUT601	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)	PBMUT504	Course Type	Theory

Course Objectives:

1. To reinforce the fundamental approaches to design philosophy and failure prevention.
2. To impart basic knowledge on design for shafts, bearings, springs clutches and brakes.
3. To provide basic design methods for gear systems.
4. To provide basic design methods for internal combustion engine parts

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Design:** Definition, steps in design process, preferred numbers, standards and codes in design. (1) Materials and their properties- combined stresses, stress concentration factor (2) **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. (2) **Design of Shaft:** 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 (6)	11
2	**Bearings:** 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, Sommerfield number, design considerations (6)	11

	Springs: Classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, end construction, design of leaf springs, design of torsion bar (5)	
3	**Design of Gears:** Classification, 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, Design procedure of Spur gear (3) Helical gears: - Terminology, Virtual or equivalent number of teeth, Tooth proportions, Beam strength, and Wear strength of Helical gears, Design procedure of Helical gear (2) Bevel gears: - Classification, Terminology, Pitch angle for bevel gears, Strength of bevel gear, beam strength, wear tooth load, Formative number of teeth, Design procedure of Bevel gear (2) Worm gears: - Characteristics of worm gears, Terminology, Advantages and disadvantages, Applications, Terms in Worm gear, Strength of Worm gear, Dynamic strength, Wear tooth load, Design procedure of Worm gear (2)	**10**
4	**Design of Internal combustion engine parts:** Crankshaft, Piston, Cylinder, Connecting rod, Flywheel, (5) **Clutches**: friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch. (4) **Brakes**: Internal expanding shoe brake, Disc brakes. (3)	**12**

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	Interpret the concept of design philosophy and failure condition	**K2**
CO2	Design automotive components of shafts, bearings, springs clutches and brakes.	**K4**
CO3	Design gear systems.	**K4**
CO4	Design internal combustion engine parts.	**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	2	3										
CO2	2		3									
CO3	2		3									
CO4	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	Design of Machine Element	V.B.Bhandari,	McGraw Hill	Fourth Edition, 2017
2	A Textbook of Machine Design	R.S. Khurmi, J.K. Gupta	S Chand	Twenty Fifth Edition, 2020.
3	Design of Machine Elements [SI E]	M. F. Spotts, Terry E. Shoup, L. E. Hornberge	Pearson Education	Eighth Edition, 2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Shigley's Mechanical Engineering Design [SI E]	Richard G. Budynas, J. Keith Nisbett, Kiatfa Tangchaichit	McGraw-Hill Series	Eleventh Edition, 2020
2	Machine Design	Robert L. Norton	Pearson Education	Fifth Edition, 2018
3	Machine Component Design	S. Shiva , Anuj K. Shukla	Wiley	First Edition, 2024
4	Design Data Handbook For Mechanical Engineers [In SI and Metric Units]	K. Mahadevan, K. Balaveera Reddy	CBS Publishers	Fourth Edition, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/112105124

SEMESTER S6

MECHATRONICS

Course Code	PCMUT602	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	PCMUT501, PCMUT503	Course Type	Theory

Course Objectives:

1. To familiarize various sensors, microprocessor, control systems and Engine management system
2. To know about the implementation of Mechatronics in automobiles
3. To understand MEMS and the working of PLC

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Mechatronics: Sensors - Characteristics - Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, grey coded encoder. Resolvers and synchro's. Piezoelectric sensors. Acoustic Emission sensors. Principle and types of vibration sensors. Inductive, Hall effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors.	9
2	Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Application of sensors in Automobiles: Throttle position, air mass flow, crank shaft position, cam position, engine and wheel speed, steering position, tire pressure, brake pressure, steering torque, fuel level, crash, exhaust oxygen	9

	level (two step and linear lambda), knock, engine temperature, manifold temperature and pressure sensors.	
3	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope. Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.	**9**
4	Fundamentals of Automotive Electronics and Microprocessor control system: Microprocessor architecture, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and Adaptive control. Parameters to be controlled in SI and CI engines and in the other parts of the automobile. Engine Management System (EMS): Introduction, remapping of ECU, Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, Fuel injection system parameters affecting combustion.	**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 of Mechatronics System	**K2**
CO2	Describe the working of different sensors and Actuators	**K2**
CO3	Understand MEMS and its fabrication methods	**K2**
CO4	Enumerate the working and applications of PLC	**K2**
CO5	Discuss the working of Microprocessors and ECU	**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
CO5	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	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering.	Bolton W.	Pearson Education Limited, New Delhi	2007
2	Mechatronics	HMT	Tata McGraw-Hill Publishing Company Ltd., New Delhi	2004
3	Electronic Engine Control Technologies	Ronald K. Jurgen	2nd Edition- -SAE International	
4	Mechatronics: Integrated Mechanical Electronic Systems	Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram	Wiley India Pvt. Ltd., New Delhi	2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Mechatronics and Measurement Systems	David G. Aldatore, Michael B. Histand	McGraw-Hill Inc., USA	2003
2	Smart Material Systems and MEMS: Design and Development Methodologies	Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan	John Wiley & Sons Ltd., England	2006
3	Industrial Robotics	Gordon M. Mair	Prentice Hall International, UK	1998

SEMESTER S6

ELECTRIC AND HYBRID VEHICLES

Course Code	**PEMUT631**	**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**	Program Elective

Course Objectives:

1. To give a general overview of Hybrid Electric vehicles, Architecture of Hybrid Electric Drive Trains, control of various motors and drives.
2. To give knowledge on the power transmission as well as the energy storage components of electric and hybrid vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Electric and Hybrid Vehicles: - History and Evolution, social and environmental importance. Types of Electric and Hybrid vehicles, Basic Components and Architecture of Electric vehicles and Hybrid vehicles. Basic component of an electric and hybrid vehicles, Fundamentals of Hybrid electric vehicles: - Types, Induction motors and drives, configuration, controls, and applications. Permanent magnet motors-neodymium and ferrite and samarium cobalt types and drives configuration, Brushless DC Motor (BLDC), Interior Permanent magnet (IPM), Switch reluctance motors (SRM) W-Axial,3 phase Induction controls and its applications.	9
2	Batteries and Storage devices: - Types of batteries – Lithium ion, Nickel Metal hydride, Sodium based batteries, Metal- air batteries, Supercapacitors and flywheels, Battery charging strategies, charge equalisation. Fuel cells and applications: - Basic principle of Hydrogen fuel cell, practical efficiency of fuel cells.	9

	Motor Controllers/Inverters, Selection of automotive IGBT and MOSFET's, Field Oriented Control (FOC) & Space Vector Pulse Width Modulation (SVPWM) of Motors, Gearbox, selection of gear ratio, Different kinds of gearboxes, Gearbox optimisation, Transmission, Different kinds of transmission.	
3	EV charging infrastructure and technology: - Fast charger, DC charger, AC charger, Wireless charging and Battery swapping, Different charging protocols CHAdeMO, CCS2, GB/T, Customised charging protocols, Battery Box Engineering, Battery Management Bus Bar design, Battery Pack Design, Various Sensors and Sensing methods, Battery Safety Standards, power electronics – Inverters, converters, and controllers, Thermal Management system of power electronics.	**9**
4	Vehicle Validation, System Integration, Controller Area Networking (CAN) and Vector Tools Simulation, Vehicle Sensors specific to EV sensors interfaced to the ECUs in the vehicle network, Hardware & Software Interfaces and Implementation challenges and examples to solve, Chassis design, Battery Positioning.	**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 general architecture, motors, drives and control devices of electric and hybrid vehicles.	**K2**
CO2	Give an overview on various power storage and transmission strategies on electric and hybrid vehicles.	**K2**
CO3	Describe various charging, management systems and sensors associated with electric and hybrid vehicles.	**K2**
CO4	To give an overview on the Vehicle Validation System Integration, Controller Area Networking and Vector Tools Simulation	**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											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	Electric and Hybrid Vehicles	Tom Denton	Routledge	1st edition 2016
2	Electric & Hybrid Vehicles	A.K. Babu	KHANNA PUBLISHING HOUSE	1st edition 2019
3	Electric and Hybrid Vehicles Design Fundamentals,	Iqbal Husain	CRC Press	2nd Edition 2010

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Hybrid Electric Vehicles Principles and Applications with Practical Perspectives	Chris Mi, M. Abul Masrur	Wiley	2nd Edition 2017
2	Electric and Hybrid Cars A History	Curtis D. Anderson, Judy Anderson	McFarland, Incorporated, Publishers	2nd edition 2010
3	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Mehrdad Ehsani, Yimin Gao, Ali Emadi	CRC Press	2nd edition 2009

SEMESTER S6

AUTOMOTIVE EMBEDDED SYSTEMS

Course Code	**PEMUT632**	**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**	Program Elective

Course Objectives:

1. To understand the role, importance, and applications of Embedded Systems in Automotives.
2. To understand the types, features, and selection criteria of communication protocols, sensors, actuators, and microcontrollers used in automobiles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Automotive Embedded Systems: -** Basic Overview, Embedded vs general computing systems, Components and applications of automotive embedded systems, Microcontroller based embedded system architecture. **Microcontrollers used in Automotives: -** Types, features, and Selection criteria, 8051 – features, architecture, pin configurations, Bus, interrupts, registers, timers, applications of 8051(Description only, no programming).	9
2	**Automotive Sensors and Actuators: -** Types and functionality of sensors-position, temperature, lambda, speed, pressure, and radar. Linear, rotary actuators – principle of operation, Piezoelectric actuators. Integration of sensors and actuators in embedded systems.	9
3	**Vehicle Communication protocols: -**Introduction, Requirement of communication protocol, vehicle networking and data communication systems, Basic functionalities of CAN, PSI5, LIN, FlexRay and Automotive Ethernet. Diagnosis system protocols -OBD. (General descriptions only)	9

	Automotives Real-Time Operating Systems (RTOS): - Introduction, types, and importance of RTOS, (General descriptions only), Automotive Open System Architecture (AUTOSAR)- Architecture, advantages, and applications. (General descriptions only)	
4	**Embedded system components, functionalities, and features**: – ADAS, Powertrain control module (PCM), Engine control module (ECM), Transmission control module (TCM), Brake and stability control system, Navigation and Telematics, Vehicle to Vehicle communication, Vehicle to everything communication.	**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	Study the components, applications and features of automotive embedded systems	**K2**
CO2	Understand the basic characteristics, selection criteria, and applications of RTOS, microcontrollers, sensors, and actuators.	**K2**
CO3	Discuss about the automotive communication and diagnosis protocols.	**K2**
CO4	Learn the role of embedded systems in advanced vehicle security and comfort 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	3											2
CO2	3											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	Automotive Embedded Systems Handbook	Francoise Simonot-Lion, Nicolas Navet	CRC Press	1st edition 2017
2	8051 Microcontroller: - An Applications Based Introduction	D. M. Calcutt, David Calcutt, Frederick Cowan, Hassan Parchizadeh	Elsevier Science	2003
3	Sensors for Automotive Applications- Volume 4	Hans-Joachim Queisser	Wiley	2006
4	Vehicle Safety Communications Protocols, Security, and Privacy	Tao Zhang, Luca Delgrossi	Wiley	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automotive Embedded Systems Key Technologies, Innovations, and Applications	M. Kathiresh, R. Neelaveni	Springer International Publishing	2021
2	Microcontrollers	Deepali A. Godse, Atul P. Godse	Amazon Digital Services LLC - KDP Print US	2020

SEMESTER S6

VEHICLE PERFORMANCE AND TESTING

Course Code	**PEMUT633**	**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**	Program Elective

Course Objectives:

1. To explain about the various vehicle performance parameters, and its testing methods.
2. To give an overview of crash test, Noise, vibration, and harshness in automotives

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to vehicle performance parameters: - Speed, power, torque, acceleration, handling, stability, load capacity. Laboratory testing: Basic engine parameters, Measurement of BHP, IHP- Engine testing on dynamometers, different types of dynamometers- hydraulic, eddy current. Vehicle testing on chassis dynamometers: two-wheel & four- wheel dynamometers. vehicle testing lanes – side slip testers, brake testers, head light alignment testing. Air and hydraulic brake test, air brake actuator, valves test, performance requirements. Parking brake - drawbar pull test, grade holding test.	9
2	Engine analysers- for petrol and diesel engines, exhaust gas analysers - various types- Orsat apparatus, infrared gas analysers, smoke meter. Energy consumption tests-Engine Cooling fan, air conditioning and brake compressors. Fuel Consumption Test, test route selection, Vehicle test speeds. Wind Tunnel Test: Test requirements – ground boundary simulation-wind tunnel selection and Reynolds number capability, model requirements, model details, model mounting, test procedure.	9
3	Collision And Crash Testing: Human Testing, Dummies, Crash worthiness, pole crash testing, near crash testing, vehicle to vehicle impact, side impact	9

	testing, crash test sensor, sensor mounting positions, crash test data acquisition, braking distance test. Bumpers - types of tests, pendulum test, fixed collision barrier test procedure, performance criteria.	
4	Noise vibration and Harshness: 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 noises, transmission noises, brake squeal, structure noise, noise control methods. Ride vibration and body test: Vibration measurement instrument - accelerometer and signal conditioning.	**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 engine performance parameters and different engine testing methods	**K2**
CO2	Understand the concepts of crash test, and wind tunnel testing techniques	**K2**
CO3	Discuss the importance of Noise, vibration, and harshness in the comfort of automotives and ride 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										2
CO2	3	2										2
CO3	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	Performance Automotive Engine Math	John Baechtel	CarTech	2011
2	Engine Testing Theory and Practice	Anthony Martyr, Michael Alexander Plint	Elsevier Science & Technology	2012
3	Internal Combustion Engines	R.P. Mathur, M.L Sharma	Dhanpat Rai Publications	2005

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	Automotive Technology	James D. Halderman	Pearson India	2008

SEMESTER S6

NON – DESTRUCTIVE TESTING

Course Code	PEMET636	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 comprehend the fundamental ideas, methodologies, tools, applications and constraints of NDT approach.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Visual Inspection:** Fundamentals of visual testing, tools, applications and limitations. Vision, lighting, material attributes, environmental factors. Visual perception, direct and indirect methods, mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources special lighting, a systems, computer enhanced system. **Liquid penetrant Testing:** properties required for a good penetrants and developers - Types of penetrants and developers. LPI technique/ test procedure interpretation and evaluation of penetrant test indications, false indication and safety precaution required in LPI.	9
2	**Magnetic Particle Testing:** Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, and magnetization using yokes. Direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI. **Eddy Current Testing:** physics aspects of ECT. Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration	9

	of ECT, relation between frequency and depth of penetration in ECT. Equipment and accessories, Various application of ECT such as conductivity measurement, hardness measurement, defect detection coating thickness measurement.	
3	**Ultrasonic Testing:** UT testing methods, contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques, resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used. Reference blocks with artificially created defects, calibration of equipments. **Radiography Testing (RT):** Electromagnetic radiation sources. Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real-time radiography, films used in industrial radiography, types of film, speed of films, qualities of film screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results, safety aspects required in radiography.	**11**
4	**Advanced NDI Techniques:** Principle and Procedure of Digital Signal and image Processing & Digital Image correlation, Acoustic emission Inspection, Thermography, Computed Tomography	**7**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	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	Have a basic knowledge of NDT Techniques which enables to carry out various inspections in accordance with the established procedures.	**K2**
CO2	Familiarize with basic principles of electromagnetic NDT methods	**K2**
CO3	Apply the principles of signal processing of ultrasonic signals and image processing of radiographic images.	**K3**
CO4	Have a better knowledge in the field of advanced techniques in NDT	**K2**

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	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Practical Non- destructive testing	Baldev Raj	Alpha Science International	2008
2	Non - destructive testing	Hull V and V John	McMillan	2012
3	Non Destructive testing Techniques	Ravi Prakash	New Academic Science	2009

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Recent developments in the field of non-destructive testing, safety and material science	Elena Lysenko, Alexander Rogachev, Oldrich Stary	Springer	2022
2	New Technologies in electromagnetic non-destructive Testing	Songling Huang & Shen Wang	Springer	2016
3	Recent Advances in Non - Destructive Inspection	Carosena Meola	Nova Science publishers	2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
I to IV	https://archive.nptel.ac.in/courses/113/106/113106070/

SEMESTER S6

MARKETING MANAGEMENT

Course Code	**PEMET638**	**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 evaluate the Marketing concepts and ideas.
2. To analyse the consumer behaviour in the market.
3. To interpret the ideas in pricing of products.
4. To identify modern day advertisement and marketing methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**INTRODUCTION**: Definition of Marketing- Evolution-Marketing concept- Marketing mix- 4 Ps Frame work-Marketing orientation and philosophies.: Types of Markets-Different Market segmentation- Non segmented markets- Benefits- Limitations **MARKETING RESEARCH & ENVIRONMENT**. Stages in Marketing research- Types of Research Methods- Exploratory- Descriptive- Experimental -Survey Methods Marketing Environment- Micro& Macro environment -Factors affecting- Economic-Technological- political -Competitive Environment-Green Marketing concept.	9
2	**CONSUMER BEHAVIOUR**:- Consumer Psychology- Choice criteria- order management cycle – Buying situation- Personal and social influence . **PRODUCT DECISION**: Concept of a Product – Types of Products- Business, Consumer , Service product-.Commodity- Technology and	9

	Customised product .New product development- Product idea-Product Life Cycle. Brand- Brand attributes- Building a brand name -strategies of corporate Branding.	
3	**PRICING STRATEGIES:** setting the price of a product-pricing policies and constraints-factors influencing pricing decision-Methods of pricing- cost oriented -competitor oriented- marketing oriented pricing -tactics of price adjustment. price wars- price sensitivity **CHANNEL DECISION-** Nature of Marketing Channels –. Types of Channel flows –Consumer- Industrial-Service channels. Functions of Distribution Channel – Structure and Design of Marketing Channels -Channel co-operation, conflict and competition – Channel Intermediaries-Franchising Retailers and wholesalers-Theory of retailing.	**10**
4	**ADVERTISEMENTS**: Advertisements- Identifying audience - Types of Advertisements-Impact of advertisements. Role of Media in advertisements-Advertisement restrictions & legal actions. **DIRECT & INTERNET MARKETING**: Direct marketing Techniques-Direct mail-Tele marketing- catalogues- direct response. Internet Marketing-Types of Networks- e business practices in post covid era. B2B-B2C-C2C-C2B exchanges.	**8**

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 familiarise with the basic terms of marketing.	**K1**
CO2	Evaluate the marketing concepts and ideas	**K2**
CO3	Identify the consumer concepts in buying	**K1**
CO4	Understand the method of channelling the product	**K1**
CO5	Analysis of various pricing strategies in the market	**K3**
CO6	Analyse the modern day advertising methods	**K3**
CO7	Understand the digital marketing methods	**K1**

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	1	-	-	-	-	1	1	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	-	1	1	-	-	-	-	1
CO4	1	1	1	1	-	-	-	-	-	-	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	2
CO6	2	-	-	-	-	-	1	-	-	-	-	1
CO7	2	1	-	-	-	-	-	-	-	-	-	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	Marketing Management	Phillip Kotler, Kevin Lane Keller	Pearson Publication	15th Edition (2018)
2	Marketing Management	Arun Kumar, N Meenakshi	Vikas Publishing house	2nd Edition (2013)
3	Research for Marketing decisions	Paul E Green, Donald S Tull, Gerald Albaum	PHI learning	5th Edition (2010)
4	Managing Marketing	Noel Capon, Sidharth Shekhar Singh	Wiley Publications	1ST Edition (2014)

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Marketing Analytics	Wayne L Winston	Wiley publication	2nd Edition 2018
2	Strategic Market Management-Global perspective	David A Aaker, Damien McLoughlin	Wiley Publications	3rd Edition 2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/110/104/110104068/
2	https://archive.nptel.ac.in/courses/110/104/110104068/
3	https://archive.nptel.ac.in/courses/110/104/110104068/
4	https://archive.nptel.ac.in/courses/110/104/110104068/

SEMESTER S6

VEHICLE MAINTENANCE AND TROUBLESHOOTING

Course Code	**PEMUT635**	**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	None	**Course Type**	Elective

Course Objectives:

1. Understand the importance, need and general procedures of vehicle maintenance.
2. Learn the basic diagnosis techniques and the tools used to rectify the issues.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to vehicle maintenance: -** Need, Types of maintenance systems, Vehicle maintenance schedules. Service station types and layouts, Workshop documentation and records- Job card. General workshop operations and procedures. Basic tools, jacks, Press and lifts in a workshop. Basic equipments in a workshop- Tyre changer, Wheel balancer, wheel aligner, Pressure washers, Engine analysers. Basic measuring instruments – Gauges, rule, vernier, dial gauge, plug gauge, feeler gauge, **Engine service repair and Overhauling: -** Basic Engine parts, engine disassembly, Engine cleaning and repair, Cylinder head repair and service, Cylinder block service, Engine problems diagnosis, techniques, and procedures- Engine overheating, Engine smoke analysis, Noise diagnosis. Valve diagnosis, Cylinder leak and compression test, Engine Balance, and testing.	9
2	**Servicing, repair and overhauling of Petrol engine fuel system: -** Components of fuel system, Preventive maintenance of fuel system. Symptoms, possible faults, repair, and replacement procedures of components in fuel system, Common services to be carried out. **Servicing, repair and overhauling of Diesel engine fuel system: -** Components of fuel system- Symptoms and possible faults, Diesel engine	9

	smoke- colours, causes. Services in diesel engine injection system, Fuel pump calibration. **Servicing, repair and overhauling of ignition system: -** Components, Overview of electronic ignition system and Distributorless ignition system. Preventive maintenance and repairs in ignition system, Symptoms, and possible issues.	
3	**Servicing repair and overhauling of Transmission system: -** Basic parts, Preventive maintenance, and repairs of Automotive transmission components- Clutch, Gearbox, Differential, drive shafts and final drive. Symptoms and possible faults in Clutch, manual transmission, automatic transmission, and drive shafts. **Servicing repair and overhauling of Cooling system: -** Overheating issues, Preliminary Checking, regular maintenance and repairing of cooling system components, Leak detection and repair of cooling system. **Servicing repair and overhauling of Lubrication system: -** General lubrication flow in automotives, Preventive maintenance and servicing of lubrication system, Diagnosis, and repair- Engine oil leak, Low or high oil pressure, excessive oil consumption. **Servicing repair and overhauling of suspension system: -** Overview of suspension components, Preventive maintenance diagnosis and repair of suspension system components – Ball joints, strut, stabilizer, springs, shock absorbers.	**9**
4	**Servicing repair and overhauling of Braking system: -** Components of braking system, Preventive maintenance, inspection, diagnosis, and repair of Braking system components – Calliper, brake pad, rotor, Master cylinder, wheel cylinder, brake lines, pneumatic cylinders, valves. **Servicing repair and overhauling of Steering system: -** Steering system components, Checking steering geometry. Possible reasons for steering misalignment, Power steering diagnosis, and repair. **Servicing repair and overhauling of HVAC systems: -** Components of Heating Ventilation and Airconditioning systems, Symptoms and possible faults, Servicing in HVAC systems, Leak detection and repair.	**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 basis preventive maintenance of automobiles and the basic tools and equipments used for the maintenance.	**K2**
CO2	Identify the preventive maintenance procedures for the components of internal combustion engines, transmissions, drivetrains, electrical systems, brakes, suspension, steering, HVAC, and fuel systems,	**K2**
CO3	Conduct inspections and analyse potential issues in engines, transmission, braking, cooling lubrication, steering and suspension system.	**K4**
CO4	Analyze and diagnose the root causes of these problems using systematic troubleshooting methods and implement effective solutions to resolve diagnosed issues	**K6**

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	3	2	2					2			2
CO4	3	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	Vehicle maintenance and garage practice	Jigar A Doshi, Shruv U Panchal, Jayesh P Maniar	PHI Learning	1st edition 2014
2	Automotive Technology: Principles, Diagnosis, and Service	James D. Halderman	Pearson	6th Edition 2019
3	Automotive Maintenance and Light Repair	Rob Thompson	Delmar Cengage Learning	2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	DIY Car repairs – A Beginners Guide	David R Ely	David Ely	First 2024
2	Auto Repair for Beginners Basic Car Repair and Maintenance for Beginners	Landon F McReynolds	Amazon Digital Services LLC	2024
3	Today's Technician: Automotive Engine Repair & Rebuilding	Chris Hadfield and Mark Schnubel	Delmar Cengage Learning	5th edition 2013
4	Ultimate Car Repair and Maintenance	Roonie D Kissner	Amazon Digital Services LLC	2024

SEMESTER S6

VEHICLE DYNAMICS

Course Code	PBMUT604	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)	PCMUT303 PCMUT402 PBMUT504	Course Type	Theory

Course Objectives:

1. Examine the dynamics of automotive systems and assessing their performance parameters.
2. Provide students with hands-on experience in simulating the dynamics of ground vehicles.
3. Determine the longitudinal, lateral, and vertical stability of the vehicle and their influence on vehicle dynamics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to vehicle dynamics:** History of road and off-road vehicle system dynamics. Vehicle coordinate systems- vehicle fixed coordinates system, earth fixed coordinate system, SAE coordinate system. Fundamental approaches to vehicle dynamics modelling lumped mass, vehicle fixed coordinate system, motion variables, Euler angles, forces, Newton's second law. Modelling and simulation of dynamic behaviour of vehicle, motion analysis, force analysis, and energy analysis using software (simple models). **Performance of road vehicles**: Forces and moments on vehicle, equation of motion, tire forces, rolling resistance, weight distribution, tractive effort/tractive resistance and power available from the engine/ power required for propulsion, road performance curves- acceleration, grade ability, drawbar pull and the problems related to these terms.	11
2	**Longitudinal dynamics:** Calculation of maximum acceleration braking torque, braking force, brake proportioning, braking efficiency, stopping distance, load distribution (three wheeled and four wheeled vehicles), calculation of acceleration, tractive effort and reactions for different drives,	11

	Stability of a vehicle on slope, (Problems related to these). Weight transfer during acceleration, cornering and braking MATLAB simulation for longitudinal dynamic response during acceleration and braking of automotive system. Vehicle dynamic Control, modelling of actuators, sensors for automobile control, sensors for detecting vehicle environment, central tyre inflation system. Prediction of vehicle performance. ABS, stability control, traction control.	
3	**Introduction to lateral dynamics -** Development of lateral forces. slip angle, cornering force, cornering stiffness, pneumatic trail, self-aligning torque, power consumed by tire, tire stiffness, hysteresis effect in tires, steady state handling characteristics. yaw velocity, lateral acceleration, curvature response & directional stability. Stability of a rigid vehicle and equations of motion of a rigid vehicle, cross wind handling, the problems related to these terms. **MATLAB simulation for lateral dynamic** response during cornering of automotive system. Stability of a vehicle on a curved track and a banked road. gyroscopic effects.,	**11**
4	**Introduction to vertical dynamics -** Human response to vibrations, classification of vibration, specification and vibration, sources of vibration, suspension systems, Modal Analysis, One DOF, two DOF, free and forced vibration, damped vibration, magnification and transmissibility, body vibrations: bouncing and pitching. doubly conjugate points (only basic idea). body rolling. roll centre and roll axis, roll axis and the vehicle under the action of side forces, stability against body rolling. **Vehicle dynamics and suspension design for stability**. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model. Matlab simulation for vertical dynamic response to analyze ride, pitch and roll of automotive system, Matlab simulation for Half Car Model, Matlab simulation for Quarter Car Model	**11**

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

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microprojects	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
• 1 Questions from each module. • Total of 4 Questions, each carrying 2 marks **(4x2 =8 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)**	**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 vehicle system dynamics and performance of road vehicles	**K5**
CO2	To develop an analytical model in MATLAB to assess the stability of a ground vehicle during braking and acceleration.	**K5**
CO3	To asses the lateral dynamics of ground vehicle using MATLAB package.	**K5**
CO4	To Simulate the vertical dynamic response to analyze ride, pitch, and roll of an automotive system, including MATLAB simulations for both the Half Car Model and the Quarter Car Model.	**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	-	-	-	-	1	-	-	-	1	1	1
CO2	3	3	3	-	3	2	-	-	2	3	2	2
CO3	3	3	3	-	3	2	-	-	2	3	2	2
CO4	2	3	2	-	3	2	-	-	2	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	Fundamentals of Vehicle Dynamics	Thomas D. Gillespie	Society of Automotive Engineers Inc	1992
2	Automotive Mechanics	N.K.Giri	Khanna Publishers	2013
3	Road Vehicle Dynamics: Fundamentals and Modeling with MATLAB	Georg Rill, Abel Arrieta Castro	CRC	2020
4	Vehicle Dynamics and Control	Rajesh Rajamani	Springer	1^{st}, 2005

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Vehicle Dynamics: Theory and Application	Reza N Jazar	Springer	2008
2	Theory of Ground Vehicles	J. Y. Woung	John Willey & Sons	2008
3	Mechanics of Road Vehicles	W. Steed	Iliffe & Sons	1962
4	Fundamentals of Vehicle Dynamics and Modelling: A Textbook for Engineers with Illustrations and Examples	Bruce P. Minaker	Wiley	2019
5	Vehicle Handling Dynamics Theory and Application	Masato Abe	Science direct	2015
6	The Multibody Systems Approach to Vehicle Dynamics	Blundell	Butterworth-Heinemann	2014

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/107106080
2	https://nptel.ac.in/courses/107106080
3	https://nptel.ac.in/courses/107106080
4	https://nptel.ac.in/courses/107106080

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 to achieve best fuel economy, reduced emission and optimum road performance, Closed loop and open loop operation, electronic engine management systems, Electronic	9

	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	1st 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

TRACTORS AND FARM EQUIPMENTS

Course Code	**OEMUT613**	**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)	OEMUT613	**Course Type**	Theory

Course Objectives:

1. To familiarize the components and working of tractors.
2. To understand the constructional features and uses of farm equipment

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Tractors and tractors units-** General description of tractors: classification of tractors, Components of tractor. Controls and Instruments, Applications of tractors, rating of tractors, wheeled and crawler tractor. Layout of wheeled and crawler tractors, crawler details, safe driving and implement hitching.	**9**
2	Engines in Tractors – Working of Four stroke diesel Engines- Fuel system- Air System- Turbochargers- Engine lubrication systems- Engine cooling Systems. Tractor Transmission system- Clutch- single plate and multiplate, Gear boxes- Differential- Rear axle- Final Drive, four-wheel drive, Power take off. Braking systems in tractors.	**9**
3	Tractor hydraulic systems- Circuits- control systems- hydraulic linkages. Electrical systems – Battery, Charging systems, Starting systems, Lights and fuses. Wheels and tyres in tractors – Tyre characteristics and specifications, Wheel track setting, Steering in tractors.	**9**

4	**Introduction to Farm equipment-** Introduction to harvesting - Principles and types of cutting mechanisms. Study of harvesting operation– harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working. Introduction to threshing systems – manual and mechanical systems. Types of threshers- tangential and axial, their constructional details and cleaning 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 design and functionality of tractor	K2
CO2	Understand the working principle of engines and transmission	K2
CO3	Comprehend hydraulic systems and wheel specifications.	K2
CO4	Comprehend Farm Equipment and Harvesting 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	2				1					2		1
CO2	2				1					2		1
CO3	2				1					2		1
CO4	2	1			1					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	Farm Machinery – An Approach.	Jain S. C., and Grace Philip.	Standard Publishers Distributors., New Delhi	2012.
2	Principles of Agricultural Engineering Vol. I.	Ojha, T. P. and Michael, A. M.	Jain Brothers, New Delhi	2011.
3	Moving the earth	Herbert Nicholas, David Day	McGraw Hill Edn.,	2010
4	Construction equipment and its management	S.C. Sharma	Khanna Publishers	2019

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Tractors and Automobiles	Rodhiev and Rodhiev	MIR. Publishers, Moscow	1987
2	Farm Machines And Equipment	Nakra C.P	Dhanpat Rai Publishing Company (P) Ltd-New Delhi	2003

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. Excavators: General description, classification based on attachments, face shovel, drag shovel, hoe, drag-line and grab or clam shell, advantages and limitations.	9

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. Tomlingson	Elsevier	1st Edition, 2010

SEMESTER S6

ALTERNATE FUELS AND ENERGY SYSTEMS

Course Code	**OEMUT615**	**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 basic characteristics of fuels & fuel additives.
2. To understand various types of alternative fuels and their environmental impacts
3. To understand the production, storage and handling techniques of hydrogen fuel technologies.
4. To understand the potential of Electric and Fuel Cell Vehicles

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Fuels** - Classification, Types, Combustion equations, Stoichiometry, Combustion analysis of fossil fuels by mass and volume – calculation of air quantity **Fuels Properties**- Calorific value, Viscosity, Flash & Fire point, Octane no, Cetane no., Properties for SI Engine fuels & CI Engine fuels, Fuel properties affecting engine performance. Emissions – main pollutants & its control, **Fuel Additives** – Need, Types, commonly used additives.	**9**
2	**Alternative fuels** – Advantages and disadvantages of conventional fuels, Need for alternative fuel, Types of Gaseous alternate fuels - LPG, CNG, LNG, Types of Liquid alternate fuels- Alcohol, Ethanol, Methanol, Di-Methyl Ether, Di-Ethyl Ether. Availability, performance, emission and desired properties of alternate fuels, Relative merits, and demerits of alternate fuels. **Biofuels** - Biodiesel and Biogas, production, blending criteria, blending process, Advantages of blending, Performance and emission of biodiesel fuelled vehicles.	**9**

3	**Hydrogen Fuels** – Sources of hydrogen, Production methods, Storage and handling, Hydrogen Induction Techniques in IC engines, Modifications required in the engine for hydrogen fuel, Performance and emission characteristics, Safety aspects **Fuel Cell Vehicles -** Layout of a Fuel Cell vehicle, Fuel cell types - alkaline fuel cell. Proton exchange Membrane; direct methanol fuel cell. Phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, power rating and performance.	9
4	**Electric Vehicle -** Layout of an electric vehicle, advantages and limitations, specifications, system components, high energy and power density batteries, **Hybrid vehicles -** components, advantages and disadvantages, Application. 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

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 understand the differences between conventional fossil fuels, alternative fuels and Biofuels.	**K2**
CO2	Acquires the knowledge of properties of hydrogen and hydrogen vehicles	**K2**
CO3	To understand basic concepts of Electric, Hybrid and Fuel Cell Vehicles	**K2**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2					1					2
CO2	1	2					1					2
CO3	1	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	Alternative fuels and Advanced vehicle technologies	Kavati Venkateswarlu B S R Murthy	PHI Learning	2020 January
2	Alternative Energy Systems and Applications	B.K Hodge	WILEY	2nd Edition, 2017
3	Alternative Fuels	S.S.Thipse	Jaico Publications	1st Edition, 2010.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Alternative Fuels Guide Book	Richard.L.Bechfold	SAE International Warrendale	1997
2	Alternative Fuels: The Future of Hydrogen.	Michael Frank Hordesk	River publishers	3rd Edition,

SEMESTER S6

ELECTRICAL MACHINES AND MECHATRONICS LAB

Course Code	PCMUL607	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)	Basic Electrical and Electronics, Electric Vehicles - Drives and Control, Mechatronics	Course Type	Lab

Course Objectives:

1. To get an overview on the sensors, actuators, and Data acquisition systems.
2. Identify the appropriate Electrical machines required for different applications, considering the parameters like input supply voltage, output torque and speed.
3. Evaluate the performance of a single-phase transformer

SYLLABUS

Experiment No.	Experiment
1	Load test on dc series motor.
2	Load test on cumulatively compounded dc generator.
3	Load test on differentially compounded dc generator.
4	Load test on dc shunt generator.
5	Open circuit characteristics of dc shunt generator.
6	Load test on dc shunt motor.
7	Load test on three phase squirrel cage induction motor
8	Load test on three phase slip ring induction motor.
9	Starting of three phase induction motor using star-delta/autotransformer methods.
10	Load test on single phase transformer
11	OC and SC test on single phase transformer
12	Study the characteristics of P-I controller

13	Study the characteristics of RTD and thermocouple
14	PLC-Simple ladder programming using PLC trainer kit
15	Checking the engine condition using On Board Diagnosis tool and study Diagnosis trouble codes.
16	Study on the head light adjustments, aiming and focusing methods.
17	Interfacing the Sensors and actuators using LabVIEW software

Note: - 10 Experiments are Mandatory.

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 understand the sensors, actuators, data acquisition systems used in automotives.	**K2**
CO2	Analyse the performance characteristics of different types of dc and ac motors by conducting load test.	**K4**
CO3	Determine the performance characteristics of single-phase transformers.	**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				1				2			2
CO2	3	2							2	2		2
CO3	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	Electric machinery (Vol. 5, pp. 178-179). New York: McGraw-Hill.	1.Fitzgerald, A. E., Kingsley, C., Umans, S. D., & James, B.	New York: McGraw-Hill.	Vol.5,2003
2	Electric machinery and transformers	Guru, B. S., & Hiziroglu, H. R.	New York: Oxford university press.	Vol.726,2001
3	Electric drives	DW, N., & Sen, P. K.	PHI Learning Pvt. Ltd..	1999
4	Mechatronic Systems, Sensors, and Actuators	Robert H. Bishop	CRC Press	2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electrical Machinery	Bimbra P. S	Khanna Publishers	7/e, 2011.
2	A Textbook of Electrical Technology	Theraja B. L	S. Chand & Company	2005
3	Sensors Interfacing with LabVIEW- A Practical Guide to Sensors and Actuators Data Acquisition and Interfacing Using MyRIO	Hee C. Lim	CreateSpace Independent Publishing Platform	2016

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

MECHANICAL ENGINEERING (AUTOMOBILE)

SEMESTER S7

HYDROGEN ENGINES AND FUEL CELL VEHICLES

Course Code	**PEMUT741**	**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 engines and fuel cell technology, including the basic properties of hydrogen, 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 engines:** The importance of hydrogen as a clean energy carrier - Basic properties of hydrogen – Hydrogen as a fuel in SI and CI engines- Engine modifications required for hydrogen use in SI engines, CI engines. Combustion characteristics – Dual fuelling – Direct injection of gaseous fuel and Liquefied hydrogen. Direct injection of liquid fuel and liquid hydrogen. Hydrogen enrichment techniques.	**8**
2	**Hydrogen and Fuel cell technology**: An introduction to fuel cells - Historical development of hydrogen fuel cell technology - Comparison between hydrogen fuel cell vehicles and conventional internal combustion engine vehicles - - Overview of global initiatives and policies promoting hydrogen fuel cell vehicles. Detailed operation of Proton Exchange Membrane Fuel Cells (PEMFC) **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 materials and designs - Comparative analysis of different fuel cell technologies - PEMFC, Solid Oxide Fuel Cells, Alkaline Fuel Cells.	**10**

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.	**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 S7

HEATING VENTILATION AND AIR CONDITIONING SYSTEMS

Course Code	**PEMUT742**	**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 fundamental principle and working of automotive heating systems, refrigeration, and air conditioning systems.
2. To classify various air conditioning systems, components, and their operational principles, focusing on their layout.
3. To get an overview on the diagnosing, servicing, and maintenance techniques in air conditioning systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Heating Ventilation and Air conditioning**: Refrigeration and air-conditioning in automotives, air-conditioning requirements for passengers. **Air Conditioning Systems -** Classification, layouts, central, unitary air conditioning systems, Vapour compression refrigeration system, components like compressors, evaporators, condensers, expansion devices, fan blowers, Air conditioning protection, Engine protection. Basic overview of vapour absorption refrigeration system.	**9**
2	**Cooling 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. **Refrigerants:** Classification, properties, selection criteria, commonly used refrigerants, commonly used refrigerants in automobile applications.	**9**
3	**Air Distribution Systems:** Distribution duct system, sizing, supply and	**9**

	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	
4	**Heating systems in automotives**: - Automotive heaters, Types, Engine heating. **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 components of automotive refrigeration systems.	**K2**
CO2	Understand the load calculation methods for optimal cooling and heating in automotives.	**K2**
CO3	Learn the principles and design of air distribution systems, air routing and temperature control mechanisms.	**K3**
CO4	Gain proficiency in diagnosing, maintaining, and servicing air conditioning systems.	**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 and Air Conditioning	Tom Birch, Thomas Wesley Birch	Prentice Hall	2003
2	Automotive Air Conditioning: Optimization, Control and Diagnosis	Quansheng Zhang	Springer	1st Edition, 2016
3	Automotive Heating, Ventilation, and Air Conditioning Systems	Jerry Clemons	Cengage Learning	1st Edition, 2010
4	Automotive Heating and Air Conditioning	James D. Halderman	Pearson	8th Edition 2017

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	
Sl. No	**Link ID**
1	Refrigeration and air-conditioning, IIT Roorkee, Prof. Ravi Kumar https://onlinecourses.nptel.ac.in/noc22_me135/preview

SEMESTER S7

VEHICLE SAFETY AND SECURITY SYSTEMS

Course Code	**PEMUT743**	**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 importance of vehicle safety systems, active and passive safety features used in automobiles.
2. Give an overview on the basics of Automotive Cybersecurity.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Automotive Safety: Driver, passenger and pedestrian safety requirements, Active and passive safety. Introduction to passive safety systems: - Types of safety belts, Head restraints, Air bags used in automobiles (description only), Crumble zones, Head restrains, Child safety seats, Energy absorbing bumpers. Materials used for energy absorption. Balance of stiffness and toughness characteristics, characteristics of vehicle structures, Design of crash crumple zones, Modelling and simulation techniques, Optimization of vehicle structures for crash worthiness.	9
2	Types of impacts, and Impact with rebound, movable barrier tests, Roll over crash tests, Behaviour of body structures in crash testing, Regulatory requirements for crash testing. Introduction to active safety systems: - Anti-lock brake systems, electronic stability program, Traction control system, Parking assist system- Working principle and components description only.	9

3	Driver assistance systems in automobiles, Definitions, and terminology: - Automotive Collision Avoidance System: Types of Collision avoidance systems, Forward Collision Warning (FCW), Sensors used- Ultrasonic, Radar, Laser- Basic working principle. Automatic Emergency Braking (AEB), Lane Departure Warning (LDW) and blind Spot Detection (BSD). rearward field of vision in automobiles, Types of rear-view mirrors and their assessment. Warning devices,	**9**
4	Cybersecurity in automobiles: - Introduction to cybersecurity, Importance of cybersecurity in modern vehicles, Basic overview of global automotive cybersecurity standards. Potential Threats, risks and vulnerabilities faced in automotives- keyless entry, OBD, Navigation and infotainment system, Telematics systems, Vehicle control and network systems. Security measures and practices in cybersecurity. Potential consequences of Cyber-attacks.	**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 principle, components and working of various active and passive vehicle safety systems.	**K2**
CO2	Understand the importance of impact and crashworthiness in automotives.	**K2**
CO3	Understand the components and technologies used in the Driver assistance systems	**K2**
CO4	Understand the key concepts in cybersecurity, including threat modelling and risk assessment	**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
CO2	3		3									1
CO3	3	2	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	Vehicle Security System	Sheikh Hussain Shaikh Salleh	Penerbit UTM	2008
2	Automotive Safety: The Science of Vehicle Safety	John W. Smith	Wiley	2019
3	Automotive Cybersecurity Engineering Handbook	Ahmad MK Nasser	Packt Publishing	2023
4	Vehicle Security Systems	A. L. Brown	Newnes	1996

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Automotive Engineering	M. A. D. T. Schuetz	SAE International	2021
2	Introduction to Automotive Cybersecurity	Silviu Ciuta	Silviu Ciuta	2023
3	From Passive to Active: How Technology Prevents Accidents	Sharlin	Bod Third Party Titles	2024
4	Active Safety Systems Terms and Definitions	Active Safety Systems Standards Committee	SAE International	2021

SEMESTER S7

MODERN AUTOMOTIVE TECHNOLOGIES

Course Code	**PEMUT744**	**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 get knowledge in the working principles, components, and benefits of recent developments in automotives including electric, hybrid and autonomous vehicles.
2. To acquire basic knowledge in the automotive electronic systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Electric and Hybrid Vehicle Technology** Introduction to Electric and Hybrid Vehicle technologies: Low Emission Vehicle (LEV), Transitional Low Emission Vehicle (TLEV), Ultra Low Emission Vehicle (ULV), Zero Emission Vehicle (ZEV) Basic components: Inverters, Battery packs, Battery management systems, Motors, Electronic power control units. Electric wiring harness: CAN Bus, Multiplex wiring. Regenerative braking (Description only). Hybrid Electric Vehicles: Types: Series and parallel hybrid layouts, Comparison of power systems and control systems, Different modes of operation for best performance, Wireless Charging, Battery Recycling and Lifecycle Management	**9**
2	**Advanced Automotive Power Plants and Control Systems** Recent Trends in Automotive Power Plants: Stratified charge engines, Reactivity Controlled Compression Ignition engines (RCCI), Hydrogen engines, Flex fuel vehicles. Biofuels and synthetic fuels. Vehicle Operation and Engine Control: Application of sensors, actuators, and microprocessors for optimal fuel economy and performance, electronic engine management systems, Adaptive cruise control and chassis control systems	**9**

	Integrated Control Systems: Advanced integration of vehicle control systems for enhanced performance and safety.	
3	**Autonomous and Connected Vehicles** Autonomous Vehicle Technologies: Autonomous vehicle levels (0-5), Sensor technologies (LiDAR, radar, cameras, ultrasonic sensors) Driver Assistance Systems (ADAS): Vision systems in cars, Comprehensive driver assistance: Lane recognition, Traffic sign recognition, Road recognition, Object recognition Connected Vehicles and IoT: Vehicle-to-Everything (V2X) communication, Telematics and applications, Cybersecurity in connected vehicles, Over-the-air (OTA) updates, 5G in automotive communication, Human-Machine Interfaces (HMI), Role of AI and ML in autonomous vehicles	9
4	**Modern Automotive Electronics and Alternative Energy Systems** Advanced Electronics and Micro Control Systems: Electronically controlled systems: Headlights, Sunroofs, Mirrors, Electro chromic mirrors, Head-up displays, Navigation systems, Automatic climate control, Anti-theft systems, Automatic door locks, Tyre pressure sensing, Automated wipers, Antilock braking system (ABS), Electronic Stability Control (ESP). Fuel Cells and Alternative Energy Systems: Introduction to fuel cells: Operational voltages, Types (Proton Exchange membrane fuel cells, Alkaline fuel cells, Medium and High temperature fuel cells), Fuel choices, Fuel Processing, Fuel Stacks, Air supply, Auxiliary systems (Basic descriptions only)	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 concepts, components and working of electric and hybrid vehicles.	**K2**
CO2	Understand the principles, components and working of modern powertrain technologies and control systems in automotives	**K2**
CO3	Understand the basic principles and technologies behind autonomous vehicles.	**K2**
CO4	The advanced vehicle electronics, vehicle to vehicle communications and recent innovations in alternate energy systems.	**K2**

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

CO-PO Mapping Table (Mapping od 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	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	Electric & Hybrid Vehicles	A.K. Babu	Khanna publishing house	2019
2	Modern Automotive Technology Fundamentals, Service, Diagnostics	Richard Fischer	Verlag Europa-Lehrmittel Nourney, Vollmer	2014
3	Modern Automotive Technology Shop Manual	Chris Johanson	Goodheart-Wilcox Publisher	2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Modern Automotive Technology for Maintenance and Light Repair	James E. Duffy	Goodheart-Wilcox Publisher	2019
2	Modern Automotive Technology	James E. Duffy	Goodheart-Willcox Company	2009
3	Automotive Engineering: Powertrain, Chassis System and Vehicle Body	David Crolla	Butterworth-Heinemann	2009
4	Electric and Hybrid Vehicles	Tom Denton	Routledge	2016
5	Connected and Autonomous Vehicles in Smart Cities	Hussein T. Mouftah, Melike Erol-Kantarci, Sameh Sorour	CRC Press	2020

SEMESTER S7

MICROPROCESSORS AND CONTROLLERS IN AUTOMOTIVES

Course Code	**PEMUT746**	**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 basic architecture and operation of microprocessors and microcontrollers.
2. Understand the basic programming procedures of microprocessors and microcontrollers

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Microprocessor**: Microprocessor architecture and its operations, Memory, Input & output devices, 8085 – architecture and its operations, Pins and signals, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O.	**9**
2	**Basic Programming concepts**: Flow chart symbols, Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Writing assembly language programs, **Programming techniques**: looping, counting, and indexing. Additional data transfer and 16-bit arithmetic instruction, Logic operation: rotate, compare, counter and time delays, 8085 Interrupts.	**9**
3	**8051 Microcontroller Basics**: Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory, Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding.	**9**
4	**Assembly programming and instruction of 8051**: Introduction to 8051 assembly programming, Assembling, and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs,	**9**

	Jump, loop and call instructions, I/O port programming. Programming 8051 Timers. Serial Port Programming, Interrupts Programming	

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 architecture, operation, and functionality of microprocessors and microcontrollers used in automotive applications.	**K2**
CO2	Identify the key functions of components of microprocessors and microcontrollers, and understand the communication interfaces.	**K2**
CO3	Understand the basic programming of Microprocessors and microcontrollers.	**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	3	2										1
CO3	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	Microprocessor Architecture, Programming and Applications with the 8085	R Gaonkar.	Penram International Publishers	6th Edition 2013
2	8051 Microcontroller	Kenneth J. Ayala,	Cengage learning,	1997
3	Automotive Microcontrollers Volume 2	Ronald K. Jurgen	SAE International	2008

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The 8051/8052 Microcontroller Architecture, Assembly Language, and Hardware Interfacing	Craig Steiner	Universal Publishers	2005
2	Advanced Microsystems for Automotive Applications 2001	Sven Krueger, Wolfgang Gessner	Springer Berlin Heidelberg	2012
3	8051 Microcontroller An Applications Based Introduction	D. M. Calcutt, David Calcutt, Frederick Cowan, Hassan Parchizadeh	Elsevier Science	2003

SEMESTER S7

FINITE ELEMENT ANALYSIS

Course Code	**PEMUT745**	**CIE Marks**	60
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	40
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites	None	**Course Type**	Theory

Course Objectives:

1. To explain the basic steps of finite element methods, types of elements, its characteristics, and applications in commercial softwares.
2. To apply the finite element techniques in One dimensional, Two dimensional and three dimensional static and dynamic structural and heat conduction problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Finite Element Methods-Areas of Application-General steps in Finite Element Methods- Geometric modelling techniques. Derivation of the stiffness matrix using displacement technique- Spring, Bar, and truss elements – Assembly of global stiffness matrix, boundary conditions. Development of Euler beam equations- Finite element formulations.	9
2	Coordinate transformation- Global and local coordinate system, Interpolation functions for general element formulation. Stiffness Matrix of Isoparametric Elements. Patch test, Mesh convergence – Basic concept only. Different type of refinements (h, p and r). Rayleigh's- Ritz Method (Variational method) and weighted residual method. Numerical integration using Gaussian quadrature.	9
3	Development of the Plane Stress and Plane Strain Stiffness Equations: - Development of the CST, Linear-Strain Triangle (Shape functions and equations only), Galerkin weighted residual Techniques, Types of Boundary conditions (Neumann, Dirichlet and Robin)	9

4	Introduction to plate bending– finite element analysis of thin plate – finite element analysis of thick plate – Structural Dynamics, Mass matrix computation, Evaluation of eigen values and eigen vectors, Transient analysis: Euler's method, Central difference technique, Critical time step, Rigid body modes.	**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	Explain the basic principles, concepts, applications of Finite Element Methods	**K2**
CO2	Apply the mathematical formulations of finite element techniques, to derive and implement shape functions for One dimensional and two-dimensional problems.	**K3**
CO3	Analyze structural mechanics problems using Finite elements techniques for trusses, beams, frames, and Plate elements.	**K4**
CO4	Perform dynamic analysis of structures, including time-dependent problems, vibration analysis, and Transient analysis using finite element techniques.	**K4**
CO5	Develop solution techniques for beam, truss, plate elements using commercial softwares/MATLAB	**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							2
CO2	3	2			2							2
CO3	3	2			2							2
CO4	3	2			2							2
CO5	3	2	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	The Finite Element Method Its Basis and Fundamentals	Olek C Zienkiewicz, Robert L. Taylor, Sanjay Govindjee	Elsevier Science	2024
2	Textbook of finite element analysis	P. Seshu	PHI Learning	2004
3	Finite Element Method with Applications in Engineering	Y. M. Desai	Dorling Kindersley	2011
4	Introduction to Finite Elements in Engineering	Tirupathi R. Chandrupatla, Ashok D. Belegundu	Pearson Education	5^{th} edition 2021
5	A First Course in the Finite Element Method	Daryl L. Logan	Cengage Learning	2011

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	The Finite Element Method Using MATLAB	Young W. Kwon, Hyochoong Bang	CRC Press	2018
2	Introduction to Finite Element Analysis Using MATLAB® and Abaqus	Amar Khennane	Taylor & Francis	2013
3	An introduction to the finite element method	J N Reddy	McGraw-Hill Education	2006
4	Fundamental and Advanced Finite Element Analysis and Applications: with Mathematica and MATLAB Computations	M. Asghar Bhatti	Wiley	2005

SEMESTER S7

DATA ANALYTICS

Course Code	PEMUT751	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 Evolution of Data Analytics
2. To Familiarize Statistical Concepts for Data analytics
3. To understand Descriptive Analytics and Predictive Analytics Techniques
4. To Explore the fundamentals of Big Data and Business Intelligence

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Data Analysis - Evolution of Analytic scalability, analytic processes, and tools. Analysis vs reporting - Modern data analytic tools. Statistical concepts: Sampling distributions, re-sampling, statistical inference	9
2	Levels of Analytics –- Predictive Analytics – Demand forecasting Regression, Neural Networks. Dimensionality Reduction - Principal component analysis	9
3	Descriptive Analytics - Mining Frequent item sets - Market based model – Association and Sequential Rule Mining - Clustering Techniques – Hierarchical – K- Means	9
4	Introduction to Big Data Analytics- Fundamental concepts of Big Data management and Analytics Characteristics- Sources of Big Data. Introduction to Business Intelligence- Definition, Need, and Evolution of Business Intelligence System and its components	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	Explain different data analysis techniques	**K2**
CO2	Discuss the concepts behind the descriptive analytics and predictive analytics	**K2**
CO3	Familiarize with Big Data and its sources	**K2**
CO4	Illustrate different visualization techniques in data analysis	**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	1					1			2
CO2	3	3	3	3					1			1
CO3	3	3	3	1					1			1
CO4	3	3	3	3								

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data.	EMC Education Services,	John Wiley & Sons,	2015
2	Data Mining Concepts and Techniques	Jaiwei Han, Micheline Kamber	Elsevier,	2006.
3	Intelligent Data Analysis,	Michael Berthold, David J. Hand,	Springer,	2007
4	Business Intelligence, Analytics, and Data Science: A Managerial Perspective”,	R. Sharda, D. Delen, and E. Turban,	Pearson, 4th edition,	2018.

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends	Bart Baesens	John Wiley & Sons,	2013
2	Data Analytics	A. Maheshwari,	McGraw Hill Education, 1st Edition,	2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1 -4	https://www.youtube.com/watch?v=La-NZ6jOfoQ&list=PLRueFtKLr0QN7MmQ8pdpQerOe_s8vGJG4

SEMESTER S7

ADVANCED IC ENGINES AND COMBUSTION

Course Code	PEMUT752	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 advances in internal combustion engine technologies, and fuel combustion characteristics.
2. To give an insight on the advanced combustion strategies like lean burn engines and low temperature engine technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Advanced Spark-Ignition Engines -** Homogenous-Charge Spark-Ignition (HCSI) Engines, Equivalence Ratio, Engine Emissions in HCSI engines, Combustion Duration in HCSI Engines, Hydrogen in Spark-Ignited Engines, emission control devices in modern SI engines **Advanced Diesel engines**- CRDi Engines, Components of CRDi system- fuel pump, rail, rail pressure sensor, rail pressure control valve, electronic injectors- types, pulse width, duty cycle, multiple injection diesel combustion, UPCR. **Dual fuel engines: -** Concept and significance, factors affecting combustion in dual fuel engines, performance of dual fuel engines. Multifuel engines, characteristics of multi fuel engines, performance of multi fuel engines.	9
2	**CNG and LNG engines** – Direct injection natural gas engines - technologies– potential applications–relative merits and demerits, CNG/LNG conversion requirements. Non-conventional engines- Wankel engine, Stirling engine- free piston engine, VCR engines, flexi fuel engines (FFV) (Description only).	9

	Combustion in SI engines and CI engines- Thermodynamic analysis, Flame structure and speed, Cyclic variations in combustion, partial burning and misfire, abnormal combustion- Reasons.	
3	**Lean burn engines**–fundamentals of lean combustion–lean burn SI engines – engine combustion and emissions– lean limit operations, Extending the Lean Limit of Spark-Ignited Engine Operation- Through Increased Turbulence Generation, Through Partial Stratification, Using Microwave-Assisted Spark Ignition, LNT technology. **Stratified charge combustion in direct injection SI engines** – GDI engines combustion process–Turbocharged direct injection SI engines (TSI) – problems and challenges– advantages– Direct injection gasoline engines with auto ignition combustion – principles and approaches– operation and control – development of practical engines.	**9**
4	**Low Temperature Combustion Strategies-** Types, Principle, advantages, HCCI and CAI engines – fundamentals – external and internal mixture preparation techniques, effect of use of exhaust gas dilution – approaches to CAI/HCCI – Four stroke gasoline and diesel HCCI engines – HCCI fuel requirements – low temperature and premixed combustion with late injection – NADI concept of HCCI – CAI control and CAI/SI switching, Concept and working of dual fuel reactivity controlled compression ignition (RCCI) engine.	**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 modern SI and CI engine combustion technologies.	**K2**
CO2	Understand the basics of dual fuel engines and non-conventional engines.	**K2**
CO3	Understand the concept and working of CNG/LNG engines, Lean-burn engines, and stratified charge engines	**K2**
CO4	Understand the combustion characteristics of IC engines.	**K2**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											2
CO2	3		2									2
CO3	3		2		2							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	Advanced Direct Injection Combustion Engine Technologies and Development Gasoline and Gas Engines	H Zhao	Elsevier Science	2010
2	Advanced Internal Combustion Engines	K. Sudhakar, Anil Kumar	BS Publications	2016
3	Fundamentals of internal combustion engines	H. N. Gupta	PHI Learning	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Internal Combustion Engine Fundamentals	John Heywood	McGraw Hill LLC	2018
2	Advanced IC engines	S. Sathishkumar	Arpit Chhabra – E Book	2022
3	Advanced Internal Combustion Engines Practical and Application	Patel Mitkumar Narendrabhai, Patel Prakashbhai Ratubhai	Shashwat Publication	2023

SEMESTER S7

AUTOMOTIVE AERODYNAMICS

Course Code	PEMUT753	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. 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^{rth} ,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	5th, 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	5th, 2013

SEMESTER S7

TRIBOLOGY AND LUBRICATION

Course Code	**PEMUT754**	**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)	PCMET303	**Course Type**	Theory

Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts of tribology.
2. To prepare students to integrate tribological knowledge into the design and analysis of engineering systems.
3. To equip students with the analytical skills necessary to assess and solve tribological problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Tribology:** Definition and Scope, Historical development and significance in engineering. **Contact Mechanics:** Types of contact: point, line, and surface contacts, Hertzian contact theory, Deformation of solid bodies under load. **Friction:** Laws of friction, Types of friction: static, kinetic, and rolling friction Factors affecting friction. Theories of friction: adhesion, deformation, and plowing.	9
2	**Wear:** Types of wear: adhesive, abrasive, corrosive, and surface fatigue wear. **Surface Topography:** Statistical Parameters (Ra,Rz,RMS) Techniques of Surface Examination: Optical Microscopy, Electron Microscopy, Atomic Force Microscopy , Profilometry. Wear measurement techniques: Pin-on-disk Tester and the Four Ball Tester.	9
3	**Principles of Lubrication:** Hydrodynamic lubrication, Boundary lubrication, Elasto-hydrodynamic lubrication (EHL). **Lubrication Regimes:** Thick film and thin film lubrication, Mixed lubrication, Stribeck curve and its significance.	9

	Lubricant Properties and Classification: Physical and chemical properties of lubricants, Types of lubricants: oils, greases, and solid lubricants, Additives and their functions Criteria for selecting lubricants.	
4	**Surface Treatments and Coatings:** Heat treatments, surface hardening, and nitriding, Coatings: PVD, CVD, thermal spray coatings, and electroplating. **Tribology in Industries:** Tribological challenges in engines, transmissions, and braking systems, Role of tribology in machining, forming, and finishing processes, Tribological issues in tool wear and lubrication in manufacturing. **Recent Advances and Future Trends:** Emerging materials and technologies in tribology, Smart lubricants and self-lubricating materials, Sustainable tribology practices, Micro and Nano Tribology (Applications in MEMS/NEMS devices).	**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	Explain fundamental principles of tribology.	**K2**
CO2	Understand surface characterisation techniques for tribological investigations.	**K2**
CO3	Explain wear measurement techniques.	**K2**
CO4	Select and evaluate lubricants and surface treatments.	**K2**
CO5	Apply tribological knowledge in industrial applications.	**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						2
CO2	3	2										2
CO3	3	2										2
CO4	3	2				2	2					2
CO5	3	2	1			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	Engineering Tribology	G. W. Stachowiak and A. W. Batchelor	Butterworth-Heinemann,	Second, 2000.
2	Introduction to Tribology	Bharath Bhushan	Wiley-Blackwell	First , 2013
3	Engineering Tribology	John Williams	Cambridge University Press,	First, 2005
4	Tribology: Friction and Wear of Engineering Materials	I. M. Hutchings	Butterworth-Heinemann	Second, 2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Surface Engineering for Corrosion and Wear Resistance	J.R. Davis	ASM International	First,2001
2	Lubrication and Lubricant Selection: A Practical Guide	A. R. Lansdown	ASME	Third,2003
3	Tribology for Scientists and Engineers	Pradeep L. Menezes, Siddhartha Ghosh, and Bijoy Bhushan	Springer	First,2013
4	Advanced Tribology: Proceedings of CIST2008 & ITS-IFToMM2008	Jianbin Luo, Yonggang Meng, Tianmin Shao, and Qian Zhao	Springer	2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/112/102/112102014/
2	https://archive.nptel.ac.in/courses/112/102/112102014/
3	https://archive.nptel.ac.in/courses/112/102/112102014/
4	https://nptel.ac.in/courses/113108083

SEMESTER S7

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Code	**PEMUT755**	**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 the basic theory underlying artificial intelligence and machine learning and be able to formulate machine learning problems corresponding to different applications.
2. To apply the algorithms to real-world problems, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to AI and Machine Learning** Introduction, Foundations of AI, History, Applications, Intelligent Agents, Agents and Environments, Properties, Solving Problems by Searching, Search Algorithms, Adversarial Search, Introduction, Machine Learning Paradigms- Supervised, Unsupervised, Semi-supervised, Reinforcement Learning.	**9**
2	**Supervised Learning** Basics of parameter estimation - maximum likelihood estimation (MLE) and maximum a posteriori estimation (MAP). Introduction to Bayesian formulation. Regression - Linear Regression with One Variable, Linear Regression with Multiple Variables, Solution using Gradient Descent Algorithm and Matrix Method, Basic Idea of Overfitting in Regression. Linear Methods for Classification- Logistic regression, Naive Bayes, Decision tree algorithm ID3. Classification Performance measures -	**9**

	Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC. Bootstrapping, Cross Validation	
3	**Unsupervised Learning and Dimensionality Reduction** Ensemble Methods- Voting, Bagging, Boosting, Similarity measures- Minkowski distance measures (Manhattan, Euclidean), Cosine Similarity, K-means clustering, Clustering - Hierarchical Clustering, Density based Clustering, Expectation maximization (EM) for soft clustering, Dimensionality reduction – Subset selection, Principal Component Analysis	**9**
4	**Neural Networks and SVM** Perceptron, Neural Network - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function (RBF).	**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	Explain the fundamental concepts of intelligent systems and Illustrate search techniques for problem solving in intelligent systems.	**K2**
CO2	Illustrate Machine Learning concepts and basic parameter estimation methods.	**K3**
CO3	Demonstrate supervised learning concepts (regression, linear classification).	**K3**
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques.	**K3**
CO5	Illustrate the concepts of Multilayer neural network and Support Vector Machine	**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	1								2
CO2	3	2	1	1	2							1
CO3	3	2	1	1	2							2
CO4	3	2	1	1	2							2
CO5	3	2	1	1	2							2

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Artificial Intelligence: A Modern Approach, 3rd Edition.	Stuart Russell and Peter Norvig.	Prentice Hall.	4^{th} 2020
2	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	2nd edition, 2010.
3	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner Meira	Cambridge University Press	First South Asia edition, 2016.
4	Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools	Davy Cielen, Arno DB Meysman and Mohamed Ali	Dreamtech Press	2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Artificial Intelligence - A New Synthesis	Nilsson N.J.	Harcourt Asia Pvt. Ltd.	
2	Elements of Machine Learning	P. Langley	Morgan Kaufmann Series	1995

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)	None	**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 Hybid 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 Electronics	**9**

	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	Erjavec Jack	Cengage Learning, Inc	2018
2	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Ehsani Mehrdad	Taylor & Francis Inc	2019

Video Links	
Sl. No	**Link ID**
1	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)	None	**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 crumble 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	
Sl. No	**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

AUTOMOTIVE NAVIGATION AND CONTROL

Course Code	OEMUT723	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 give an overview on the various automotive navigation systems
2. To describe about various sensors used in automotive navigation system and control.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Automotive Navigation Systems: - Introduction, Recent technology developments in navigation system. Key components, Navigation data standards. GPS based navigation in autonomous vehicles – Introduction, Basic architecture of autonomous GPS vehicle, distance, and direction calculation, Global Navigation Satellite System (GNSS) based positioning in autonomous vehicles- introduction, key features, components, GPS vs GNSS.	8
2	Vision based navigation systems- Introduction, Lane positioning techniques, Lidar based positioning techniques, camera-based positioning techniques. Position, speed, heading navigation with vision measurements. Basic sensors used in vehicle navigation- Speed estimation sensors- types, principle and working. Accelerometers – types, working, GPS sensors, Wheel speed sensors, Heading sensors, Yaw rate gyroscopes. Laser radar principle and working –Non contact ground velocity sensors. Road surface recognition sensor. Looking out sensors and looking in sensors,	10
3	Vehicle dynamics estimation using GPS- Side slip- effects, calculation, tyre parameters. Vehicle control using GNSS/GPS- Introduction, techniques, Speed controlling techniques, Speed controllers used in vehicles- description. Vehicle steering control, yaw rate controller, lateral movement controller, lateral position controller.	9

4	Vision in cars – Lane recognition, Traffic sign recognition, Stereo vision, road recognition, Object recognition – Traffic lights and signals, pedestrian recognition- basic principle, architecture and working. Building intelligent systems in new generation cars. Communication technologies in vehicle information system – Vision for ITS communication – ITS communication in automobiles, vehicle to Vehicle and road-vehicle communication systems- basic principle, working. Relative merits and demerits.	**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 techniques, components and working of the vehicle navigation system.	**K2**
CO2	Understand Global Navigation Satellite System, its principles, and components with sensor details.	**K2**
CO3	Understand the basic vehicle dynamics effects and measures to control the dynamic effects.	**K2**
CO4	Understand the basic vehicle communication strategies and its effects in the vehicle control.	**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										1
CO3	3	2										1
CO4	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	Vehicle Dynamics, Stability, and Control	Dean Karnopp	CRC Press	2016
2	Navigation and Intelligent Transportation Systems	Ronald K. Jurgen	SAE International	1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	On-road intelligent vehicles: Motion planning for intelligent transportation systems	Kala, Rahul.	Butterworth-Heinemann	2016
2	Vehicle Dynamics and Control	Rajesh Rajamani	Springer US	2011
3	GPS Guided Autonomous Vehicle	Ryun Konze, Matt Gulcher, Alvin Alcaide, Erwin Nava	California Maritime Academy	2010
4	GNSS for Vehicle Control	David M. Bevly, Stewart Cobb	Artech House	2010

SEMESTER S7

VEHICLE PERFORMANCE AND TESTING

Course Code	**OEMUT724**	**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.

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)	9
2	**Energy consumption tests:** Testing methods and procedures for Engine cooling fan, air conditioning system, brake compressors- Fuel consumption tests, test route selection, vehicle test speeds **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	9

	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	
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)	**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 invarious 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, measureand 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	SAE Hand book, Vol 3		SAE, Publications	2000

SEMESTER S7

EMBEDDED SYSTEMS IN AUTOMOBILES

Course Code	**PEMUT725**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:1	**ESE Marks**	60
Credits	5	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Program Elective

Course Objectives:

1. To understand the role, importance, and applications of Embedded Systems in Automotives.
2. To understand the types, features, and selection criteria of communication protocols, sensors, actuators, and microcontrollers used in automobiles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction to Automotive Embedded Systems: -** Basic Overview, Embedded vs general computing systems, Components and applications of automotive embedded systems, Microcontroller based embedded system architecture. **Microcontrollers used in Automotives: -** Types, features, and Selection criteria, 8051 – features, architecture, pin configurations, Bus, interrupts, registers, timers, applications of 8051(Description only, no programming).	9
2	**Automotive Sensors and Actuators: -** Types and functionality of sensors- position, temperature, lambda, speed, pressure, and radar. Linear, rotary actuators – principle of operation, Piezoelectric actuators. Integration of sensors and actuators in embedded systems.	9
3	**Vehicle Communication protocols: -**Introduction, Requirement of communication protocol, vehicle networking and data communication systems, Basic functionalities of CAN, PSI5, LIN, FlexRay and Automotive Ethernet. Diagnosis system protocols -OBD. (General descriptions only)	9

	Automotives Real-Time Operating Systems (RTOS): - Introduction, types, and importance of RTOS, (General descriptions only), Automotive Open System Architecture (AUTOSAR)- Architecture, advantages, and applications. (General descriptions only)	
4	**Embedded system components, functionalities, and features**: – ADAS, Powertrain control module (PCM), Engine control module (ECM), Transmission control module (TCM), Brake and stability control system, Navigation and Telematics, Vehicle to Vehicle communication, Vehicle to everything communication.	**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	Study the components, applications and features of automotive embedded systems	**K2**
CO2	Understand the basic characteristics, selection criteria, and applications of RTOS, microcontrollers, sensors, and actuators.	**K2**
CO3	Discuss about the automotive communication and diagnosis protocols.	**K2**
CO4	Learn the role of embedded systems in advanced vehicle security and comfort 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	3											2
CO2	3											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	Automotive Embedded Systems Handbook	Francoise Simonot-Lion, Nicolas Navet	CRC Press	1st edition 2017
2	8051 Microcontroller: - An Applications Based Introduction	D. M. Calcutt, David Calcutt, Frederick Cowan, Hassan Parchizadeh	Elsevier Science	2003
3	Sensors for Automotive Applications- Volume 4	Hans-Joachim Queisser	Wiley	2006
4	Vehicle Safety Communications Protocols, Security, and Privacy	Tao Zhang, Luca Delgrossi	Wiley	2012

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Automotive Embedded Systems Key Technologies, Innovations, and Applications	M. Kathiresh, R. Neelaveni	Springer International Publishing	2021
2	Microcontrollers	Deepali A. Godse, Atul P. Godse	Amazon Digital Services LLC - KDP Print US	2020

SEMESTER 8

MECHANICAL ENGINEERING

(AUTOMOBILE)

SEMESTER S8

AUTOMOTIVE NAVIGATION AND CONTROL

Course Code	**PEMUT861**	**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 give an overview on the various automotive navigation systems
2. To describe about various sensors used in automotive navigation system and control.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Automotive Navigation Systems: - Introduction, Recent technology developments in navigation system. Key components, Navigation data standards. GPS based navigation in autonomous vehicles – Introduction, Basic architecture of autonomous GPS vehicle, distance, and direction calculation, Global Navigation Satellite System (GNSS) based positioning in autonomous vehicles- introduction, key features, components, GPS vs GNSS.	**8**
2	Vision based navigation systems- Introduction, Lane positioning techniques, Lidar based positioning techniques, camera-based positioning techniques. Position, speed, heading navigation with vision measurements. Basic sensors used in vehicle navigation- Speed estimation sensors- types, principle and working. Accelerometers – types, working, GPS sensors, Wheel speed sensors, Heading sensors, Yaw rate gyroscopes. Laser radar principle and working –Non contact ground velocity sensors. Road surface recognition sensor. Looking out sensors and looking in sensors,	**10**
3	Vehicle dynamics estimation using GPS- Side slip- effects, calculation, tyre parameters. Vehicle control using GNSS/GPS- Introduction, techniques, Speed controlling techniques, Speed controllers used in vehicles- description.	**9**

	Vehicle steering control, yaw rate controller, lateral movement controller, lateral position controller.	
4	Vision in cars – Lane recognition, Traffic sign recognition, Stereo vision, road recognition, Object recognition – Traffic lights and signals, pedestrian recognition- basic principle, architecture and working. Building intelligent systems in new generation cars. Communication technologies in vehicle information system – Vision for ITS communication – ITS communication in automobiles, vehicle to Vehicle and road-vehicle communication systems- basic principle, working. Relative merits and demerits.	**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 techniques, components and working of the vehicle navigation system.	**K2**
CO2	Understand Global Navigation Satellite System, its principles, and components with sensor details.	**K2**
CO3	Understand the basic vehicle dynamics effects and measures to control the dynamic effects.	**K2**
CO4	Understand the basic vehicle communication strategies and its effects in the vehicle control.	**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										1
CO3	3	2										1
CO4	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	Vehicle Dynamics, Stability, and Control	Dean Karnopp	CRC Press	2016
2	Navigation and Intelligent Transportation Systems	Ronald K. Jurgen	SAE International	1998

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	On-road intelligent vehicles: Motion planning for intelligent transportation systems	Kala, Rahul.	Butterworth-Heinemann	2016
2	Vehicle Dynamics and Control	Rajesh Rajamani	Springer US	2011
3	GPS Guided Autonomous Vehicle	Ryun Konze, Matt Gulcher, Alvin Alcaide, Erwin Nava	California Maritime Academy	2010
4	GNSS for Vehicle Control	David M. Bevly, Stewart Cobb	Artech House	2010

SEMESTER S8

OPERATIONAL RESEARCH AND INDUSTRIAL MANAGEMENT

Course Code	**PEMUT862**	**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. Develop models for optimizing the management and production systems from the verbal description of the real system.
2. Make use of mathematical techniques for optimization of Production mix problem in industry.
3. Demonstrate the concept of Supply Chain management.
4. To introduce fundamental issues in production and inventory planning and control and at the same time, develop the students' modelling and analytical skills.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	An overview of operations research modelling approach. Mathematical formulation of linear programming problems; Graphical solution; Simplex algorithm - artificial starting solution - Big M method - two-phase method – alternative, optimal solutions - unboundedness - degeneracy. Duality in linear programming - primal-dual relationships - economic interpretation of duality.	**9**
2	Transportation problems - formulation and solution; Assignment problems - formulation and solution. Network flow models - shortest route problem, minimum spanning tree and maximum flow algorithms. Queuing theory - generalized Poisson queuing model - steady state solution of single server models for infinite queue size and finite queue size.	**9**
3	Introduction and a strategic view of supply chains: decision phases in a supply chain, process views of supply chain; enablers of supply chain performance; supply chain performance in India: challenges in maintaining supply chain in	**9**

	India; supply chain strategy and performance measures, supply chain performance measures, enhancing supply chain performance; supply chain drivers, framework for structuring drivers.	
4	Introduction to Production Planning and Scheduling, Aggregate production plan, Formulation of lot size production problem: Wagner and Whitin algorithm. Basic concepts of Just-in-Time (JIT) and Material Requirement Planning (MRP). Introduction to inventory systems, inventory classification and its use in controlling inventory. Deterministic inventory models: Economic order quantity (EOQ) model, EOQ with finite supply, EOQ with backorders, EOQ with constraints, All-units quantity discounts model. Single period probabilistic inventory models with discrete and continuous demand, determination of reorder point for deterministic and probabilistic Inventory System.	**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	Formulate and solve decision problems using linear programming.	**K2, K4**
CO2	Understand the mathematical tools that are needed to solve optimization problems	**K2, K4**
CO3	Explain the fundamental concepts in supply chain management.	**K2, K4, K5**
CO4	Analyze the project planning activities that will predict project costs, time schedule, and quality	**K2, K4, 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	2	2	2	2				2				
CO2	2	2	1	1				2				
CO3	2		1	1				2				
CO4	2		1	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	Operation Research	P. Ramamurthy	New age international	2005
2	Operations-research-theory-and-applications	J.K.Sharma	Trinity Press	6th edition
3	Operations Research - An Introduction	H. A. Taha	Prentice Hall of India	1997
4	Productions and Operations Management.	Muhlemann, J. Oakland and K. Lockyer	Macmillan	1992
5	Supply Chain Management – Text and Cases,	Shah. J	Pearson Education	Second Edition 2016
6	Supply Chain Management: Strategy, Planning, and Operation.	Chopra, S., and Meindel, P.	Pearson Prentice Hall of India.	2016

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Planning and Inventory Control	S. L. Narasimhan, D. W. McLeavey, and P. J. Billington	Prentice Hall.	1997
2	Production Systems: Planning, Analysis and Control	J. L. Riggs	3rd Ed Wiley	1981
3	Operations Research.	J. K. Sharma	Macmillan	1997

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc22_ma48/preview#
2	https://archive.nptel.ac.in/courses/111/102/111102012/
3	https://archive.nptel.ac.in/courses/110/104/110104073/
4	https://archive.nptel.ac.in/courses/110/105/110105095/

SEMESTER 8

AUTOMOTIVE NOISE VIBRATION AND HARSHNESS

Course Code	**PEMUT863**	**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 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.	**9**

	Noise Measurement and Control- Sources of noise, Noise measuring instruments, microphones, sound intensity probes, Noise control methods, 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 matric, 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	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 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	Analyze 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 S8

RENEWABLE ENERGY SOURCES

Course Code	**PEMUT864**	**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 give an overview on the energy scenario, energy sources and their utilization.
2. To Study the types, components, principles of operation of the renewable energy conversion systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to renewable energy sources: - Classification of Energy Resources, Social implications, Conventional Energy Resources (Basic description)- Availability and their limitations- Non-Conventional Energy Resources – Classification, Relative merits and demerits, **Solar Energy**: Principle of conversion of solar radiation into heat energy, Solar thermal collectors- types, Estimation of solar radiation on flat plate collectors, Solar concentrators (parabolic trough, parabolic dish) -description, working. **Solar electric systems: -** Solar thermal electric power generation, Photovoltaic – Solar cells- types, characteristics, applications.	**9**
2	**Ocean Thermal Energy**: - Principle of working, Open cycle, closed cycle, and hybrid cycle. Relative merits and demerits. **Tidal Power**: Principle of tidal power- components of tidal system, Environmental impacts, classification of tidal systems- Single basin, Double basin, advantages, and limitations. **Wind Energy**: Basic principle of wind energy conversion system, wind speed measurements, availability of wind energy in India, Basic components of wind	**9**

	energy conversion system (WECS); Classification of WECS- Horizontal axis-single, double and multiblade system. Vertical axis.	
3	**Biomass Energy:** Introduction; Photosynthesis Process; Biomass fuels; Biomass Resources; Biomass conversion technologies, Urban waste to energy conversion; Biomass gasification, Biomass to ethanol production, factors affecting biomass production, Typer of biogas plants, Recent developments in Biomass production.	**9**
4	**Hydro power plants: -** Introduction to hydro electric power stations, layout of power station, classification, Turbines – types of turbines (description only)- selection considerations. **Fuel cell and green energy:** - Fuel Cell-principle of operation –classification-conversion efficiency and losses - applications. Hydrogen energy -hydrogen production -electrolysis- thermo chemical methods -hydrogen storage and utilization.	**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 environmental aspects of renewable energy resources.	**K2**
CO2	Understand the basic principle of conversion of solar energy, tidal energy, wind energy and ocean energy to thermal energy.	**K2**
CO3	Understand the principles of wind and tidal energy generation	**K2**
CO4	Understand the concept of biomass energy resources and green energy.	**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	Non-conventional Energy sources	G D Rai	Khanna Publication	5th Edition, 2011
2	Non-Conventional Energy Resources.	Sawhney G. S.	PHI Learning	2012
3	Non-Conventional Energy Resources	By Bansal N.K.	Vikas Publishing House	2014

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Non-Conventional Energy Sources and Utilisation	R. K. Rajput	S. Chand	2012
2	Solar Energy- Fundamentals, Design, Modelling and Applications	G.N.Tiwari	Narosa Publishing house Pvt.Ltd	Revised edition 2013
3	Wind Energy: Fundamentals, Resource Analysis and Economics.	Mathew Sathyajith	Springer	2006

SEMESTER S8

VEHICLE TRANSPORT MANAGEMENT

Course Code	**PEMUT866**	**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 provide a comprehensive understanding of the principles and practices of vehicle transport management.
2. To equip students with the skills necessary to manage and optimize fleet operations, including maintenance, fuel management, and safety compliance.

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 **Vehicle Maintenance Management** - Preventive vs. corrective maintenance. Maintenance scheduling and record keeping. Use of telematics in maintenance	9

	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	Kogan Page	2021
3	Fleet Management System A Complete Guide	Gerardus Blokdyk	The Art of Service - Fleet Management System Publishing	2021
4	Profitable Fleet Management: For Small and Medium Businesses	Bill DeBoer	Deboer Auto	2023

SEMESTER S8

ADVANCED DRIVER ASSISTANCE SYSTEMS AND AUTONOMOUS VEHICLES

Course Code	**PEMUT865**	**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 explore the various sensor technologies and their integration into autonomous and ADAS systems.
2. To understand the principles and components of autonomous driving and ADAS technologies.
3. To analyse the role of AI, machine learning, and software platforms in autonomous driving.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	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 Fundamentals of Autonomous Driving - Levels of vehicle autonomy (SAE levels 0-5), Key components of autonomous vehicles, Overview of autonomous vehicle architectures Vehicle Communication and Networking - In-vehicle networking (CAN, LIN, FlexRay), Vehicle-to-everything (V2X) communication, Role of wireless technology in autonomous driving.	**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, Image processing techniques for vehicle safety, Night vision technology and applications	**9**

	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 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	**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	Integrate and calibrate sensor and control systems in autonomous and ADAS technologies.	**K3**
CO2	Understand the security issues surrounding driverless car technology, and the role of artificial intelligence and deep learning in autonomous vehicles	**K2**
CO3	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**
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
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 S8

ADVANCED TRIBOLOGY AND NANO LUBRICANTS IN AUTOMOTIVES

Course Code	OEMUT831	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 provide a comprehensive understanding of advanced tribology concepts and the application of nano lubricants in automotive systems
2. To give an overview on various characterisation techniques in nano particles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to tribology, Friction, Wear, Bearings and lubrication, Theories of Wear, Wear classification, Introduction to Bearings and Lubrication of Bearings. Basic principles of lubrication, lubrication theories, Hydrostatic, boundary, hydrodynamic and elasto-hydrodynamic lubrication. Generalized Reynolds equation,	8
2	Mechanism of hydrodynamic instability. Dynamic characteristics of hydrodynamic journal bearings. Plain bearing lubrication and performance. Hydrostatic thrust bearing, Design, application and selection of various types of bearings– sliding and rolling element bearings.	8
3	Nanomaterials- Synthesis of nanomaterials- Physical method and Chemical methods - Characterization techniques- X-ray diffraction (XRD) technique- Scanning electron microscopy(SEM)- Transmission electron microscopy(TEM) -Scanning tunnelling microscopy(STM)- Infrared spectroscopy -Raman spectroscopy- UV visible spectroscopy- Nanofluids/Nanolubricants- Preparation of nanolubricants- One-step method- Two-step method- Various types of nanoparticles as lubricant additives-Metal	10

	oxides -Metal sulphides - Carbon-based nanoparticles- Nanocomposites -Rare earth compounds- Surface modified nanoparticles	
4	Stability of nanolubricants-Factors affecting stability- Methods of stability measurement- Zeta potential- Properties of nanolubricants-Measurement of Specific heat – Surface wetting characteristics-Thermal conductivity- Viscosity and Rheological Properties and Tribological Characteristics – Friction and wear characteristics- Lubrication mechanisms in nanolubricants- Rolling effect or ball-bearing effect-Protective film formation-Mending effect-Polishing effect- Application of nanolubricants in automobiles.	**10**

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 principles of tribology, including friction, wear, and lubrication mechanisms.	**K2**
CO2	Understand the principles in hydrostatic and hydrodynamic lubrication.	**K2**
CO3	Understand the properties, types, and characteristics of nano lubricant.	**K2**
CO4	Explore techniques for characterizing nano lubricants.	**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	Engineering Tribology	Prasanta Sahoo	PHI Learning	2005
2	Applied Tribology Bearing Design and Lubrication	Michael M. Khonsari, E. Richard Booser	Wiley	2017
3	Nanofluids Science and Technology	Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep	Wiley	2007
4	Textbook of Nanoscience and Nanotechnology	B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday	Springer Berlin Heidelberg	2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Tribology	Bharat Bhushan	Wiley	2013
2	Introduction to Tribology of Bearings	B. C. Majumdar	S. Chand	2008
3	Nanolubricants: Generation and Applications	Mohd Yusuf, Lalit Prasad, Shafat Ahmad Khan.	Wiley	2024

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)		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 materials and designs - Comparative analysis of different fuel cell technologies - PEMFC, Solid Oxide Fuel Cells, Alkaline Fuel Cells.	9

3	**Hydrogen production methods- S**team 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

Text 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

ADVANCED MANUFACTURING TECHNIQUES

Course Code	**OEMUT833**	**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)	MET205 Metallurgy & Mat erial Science	**Course Type**	Theory

Course Objectives:

1. To make acquainted the various unconventional manufacturing processes.
2. To know about the applications of advanced manufacturing processes (which are exceptional).
3. To encourage the students for developing the models of Advanced Manufacturing Processes.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Surface treatment:** Scope of surface treatment, Cleaners, Methods of cleaning, Surface coating types, ceramic and organic methods of coating, Economics of coating. Electro forming, Chemical vapour deposition, Thermal spraying, Ion implantation, Diffusion coating, Diamond coating and cladding.	9
2	**Non-Traditional Machining: Mechanical and abrasive processes-** Introduction, need, Abrasive Jet Machining (AJM), parametric analysis, process capabilities; Ultrasonic Machining (USM) –mechanics of cutting, models, parametric analysis; Water Jet Machining (WJM) –principle, equipment, process characteristics, performance. **Electro chemical processes-** Electro Chemical Machining – principle of working, equipment, material removal rate, process parameters, performance characterization and applications.	9
3	**Thermal processes-**Electrical Discharge Machining (EDM) – principles, equipment, generators, analysis of R-C circuits, material removal rate, surface finish and applications; Laser Beam Machining (EBM) – principle of working,	9

	equipment, material removal rate, process parameters, performance characterization and applications; Plasma Arc Machining – principle of working, equipment, material removal rate, process parameters, performance characterization and applications.	
4	**Processing of ceramics**: Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, drying, sintering, hot compaction, finishing of ceramics and area of application. **Processing of composites:** Classification of composites materials- Reinforcements and Matrix materials; Polymer Matrix Composites (PMC)-Processing of PMCs: Sheet molding compound, Carbon Fiber Reinforced Polymer Composites; Metal Matrix composites (MMC)- Processing of MMCs: Liquid-State Processes, Solid State Processes; Ceramic Matrix Composites (CMC)-Processing of CMCs: Cold Pressing and Sintering, Hot Pressing, Reaction Bonding Processes.	**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	Explain the surface treatment processes	**K2**
CO2	Understand various Nontraditional Machining processes	**K2**
CO3	Estimate the performance characteristics of various machining processes	**K5**
CO4	Understand the ceramics and composites processing	**K2**

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2			3							2
CO2	1	2			3							2
CO3	1	2			3							2
CO4	1	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	Advanced Machining Processes	V. K. Jain	Allied Publications	2009
2	Manufacturing Engineering and Technology	Kalpakijian	Addison Wesley	1995
3	Foundation of MEMS	Chang Liu	Pearson	2012
4	Composite Materials: Science And Engineering	Krishan K. Chawla	Springer India	2015

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Process and Materials of Manufacturing.	R. A. Lindburg	PHI	4th edition, 1990
2	Introduction to Manufacturing Processes.	John A Schey	Mc Graw Hill.	1977
3	Micro Machining of Engineering Materials.	J. Mc Geough	CRC Press	2001
4	Non-Traditional Manufacturing Processes.	Gary F Benedict	CRC Press	1987
5	Advanced Methods of Machining	J. A Mc Geough	Springer	1988

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc24_me72/preview
2	https://archive.nptel.ac.in/courses/112/107/112107078/

SEMESTER S8

AUTOMOTIVE MECHATRONICS

Course Code	**OEMUT834**	**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. Describe the role of sensors, actuators, and microcontrollers in automotive systems.
2. Compare SI (Spark Ignition) and CI (Compression Ignition) engine management principles.
3. Comprehend the principles of PLC and MEMS

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Mechatronics and Automotive Mechatronics: Structure of Mechatronics system. Sensors - Characteristics - Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive Hall Effect and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. Actuators: Mechanical actuators, Electrical actuators, Hydraulic and Pneumatic actuators Working of Sensors and actuators in Automobile – MAF, Throttle position, crank shaft position, steering torque, lambda, knock sensors	**9**
2	Fundamentals of Automotive Electronics and Microprocessor control system: Microprocessor architecture, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control.	**9**

	Applications of Mechatronics in Modern vehicles like ABS, Airbag, EBD, ESC, active suspension, rain sensing wipers, ADAS driverless cars – working with sensing & Actuating components	
3	Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes. Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.	**9**
4	Electronic Engine Management System: SI Engine Management – parameters to be controlled, Electronic Fuel Injection, Electronic Ignition System and its advantages, Fuel control maps, CI Engine Management - parameters to be controlled, Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection	**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 components of automotive mechatronics and control systems.	**K2**
CO2	Understand the basics of sensors, actuators and its interaction with automotive parameters	**K2**
CO3	Understand the basics of electronic engine management system for SI and CI Engine Management System.	**K2**
CO4	Understand the working of PLC and MEMS	**K1**

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	3			1			3
CO2	2		1		2	3			1			3
CO3	2		1		2	3			1			3
CO4	2		1		2	3			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 Mechatronics: Automotive Networking, Driving Stability Systems, Electronics (Bosch Professional Automotive Information)	Konrad Reif, Fachmedien Wiesbaden	Springer	2014
2	Automobile Electrical & Electronic Equipments	Young, Griffitns	Newnes-Butterworth	8th Revised edition,1970
3	Fundamentals of Automotive Electronics	V.A.W.Hilliers	Hatchin, London	1987

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Understanding Automotive Electronics,	Wiliam B. Ribbens	Newnes, Butterworth-Heinemann	5th Edition,1988
2	Understanding Automotive Electronics	Bechfold	SAE Publications	1998
3	Automobile Electronics	Eric Chowanietz	SAE Publications	1995
4	Diesel Engine Management	Robert Bosch	SAE Publications	3rd Edition, 2004
5	Gasoline Engine Management	Robert Bosch	SAE Publications	2nd Edition, 2004
6	Mechatronics	W Bolton	Pearson Publications	2017

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc20_de06/preview
2	https://onlinecourses.nptel.ac.in/noc24_me120/preview

SEMESTER S8

VEHICLE TRANSPORT AND FLEET MANAGEMENT

Course Code	**OEMUT835**	**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 provide a comprehensive understanding of the principles and practices of vehicle transport management.
2. To equip students with the skills necessary to manage and optimize fleet operations, including maintenance, fuel management, and safety compliance.

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 **Vehicle Maintenance Management** - Preventive vs. corrective maintenance. Maintenance scheduling and record keeping. Use of telematics in maintenance	**9**

	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