

**B.Tech. Mechanical Engineering with Specialization in Automobile Engineering**

**Programme Electives**

Sl.No	Course Code	Course Name	L	T	P	C
1	1152ME152	Automotive Aerodynamics	3	0	0	3
2	1152ME153	Automotive Materials	3	0	0	3
3	1152ME154	Automotive Testing and Certification	3	0	0	3
4	1152ME155	Engine Design and Development	2	2	0	3
5	1152ME156	Off Highway Vehicles	3	0	0	3
6	1152ME157	Vehicle Body Engineering	3	0	0	3
7	1152ME158	Structural & Vehicle Dynamics	2	2	0	3
<b>INTERGRATED COURSES</b>						
8	1152ME203	Automotive Safety	2	0	2	3
9	1152ME204	Engine Electronics and Management Systems	2	0	2	3
10	1152ME205	Engine Testing and Certification	2	0	2	3
<b>TOTAL CREDITS (Students should earn 18 credits from the above)</b>						<b>18</b>

**\* Students should earn 18 credits from the above programme electives to received degree in Mechanical Engineering with Specialization in Automobile Engineering**

**1. Preamble**

The course is meant to give the learners an introduction and an enhancement of their knowledge in the field of vehicle aerodynamics. It includes: overview of fundamentals of fluid mechanics, Boundary layers and Vorticity, Bluff body aerodynamics, Aerodynamic forces on road vehicles; their evaluation and possible strategies for their control. Design aspects of external and internal flows in vehicles.

**2. Pre-requisite:**

NIL

**3. Links to other courses**

- Vehicle Body Engineering
- Automotive Safety

**4. Course Educational Objectives**

Students undergoing this course are expected to

- Provide guidance to industry on reducing the aerodynamic drag in heavy truck vehicles
- Develop innovative drag reducing concepts that are operationally and economically sound
- Establish a database of experimental, computational, and conceptual design information
- Demonstrate the potential of new drag-reduction concepts

**5. Course Outcomes :**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Evaluate basic fluid theory.	K3
C02	Apply CFD to a range of problems.	K3
C03	Understand lift, drag and down force definitions and calculations.	K2
C04	Demonstrate a knowledge and understanding of aerodynamics in automotive field.	K3
C05	Explain the principles and functions of wind tunnel.	K2

(K2-understand, K3-Apply, K4-Analysis)

**6. Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L					L	L		M	L
CO2	H	H	H	M	L					L	L		M	H
CO3	H	H	H	M	L					L	L		M	L
CO4	H	H	H	M	L					L	L		M	L
CO5	H	H	H	M	L					L	L		M	L

H- High; M-Medium; L-Low

## 7. Course Content

### UNIT I - INTRODUCTION

L-9

Scope and historical development trends - Fundamental of fluid mechanics - Flow phenomenon related to vehicles - External & Internal flow problem - Resistance to vehicle motion - Performance - Fuel consumption and performance - Potential of vehicle aerodynamics.

### UNIT II - AERODYNAMIC DRAG OF CARS

L-9

Cars as a bluff body - Flow field around car - drag force - types of drag force - analysis of aerodynamic drag -drag coefficient of cars - strategies for aerodynamic development - low drag profiles, Lift, Body styling

### UNIT III - SHAPE OPTIMIZATION OF CARS

L-9

Front end modification - front and rear wind shield angle - Boat tailing - Hatch back, fast back and square back -Dust flow patterns at the rear - Effects of gap configuration - effect of fasteners.

The origin of forces and moments on vehicle - side wind problems - methods to calculate forces and moments - vehicle dynamics under side winds - the effects of forces and moments

### UNIT IV- VEHICLE HANDLING

L-9

Characteristics of forces and moments - Dirt accumulation on the vehicle - wind noise - drag reduction in commercial vehicles.

### UNIT V - WIND TUNNELS FOR AUTOMOTIVE AERODYNAMIC

L-9

Introduction – Principle of wind tunnel technology – Limitation of simulation – Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods – Numerical methods.

**Total: 45 Periods**

## 8. Text Book

1. Wolf – Heinrich Hucho, Aerodynamics of Road Vehicles, SAE, ISBN No: 978-0-7680-0029-0, 1998.
2. Heinz Heisler, “Advanced Vehicle Technology”, second edition, Butterworth – Heinemann, New York, 2002

## 9. Reference Books

1. Pope. A., Wind Tunnel Testing, John Wiley & Sons, 2nd edition, New York, 1974.
2. Sumantran. V, Gino Sovran, Vehicle Aerodynamics, SAE, 1994

## 10. Revised Bloom’s based Assessment Pattern:

Revised Bloom’s Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand			10	10	15
Apply	40	40	40	40	30
Analyse	40	40	40	40	40
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	80	80
Apply	20	20
Analyse		
Evaluate		
Create		

### 11. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
	<b>UNIT -I</b>	<b>(9)</b>	
1	Scope – historical development trends	1	Lecture with Discussion /Assignment/ Seminar
3	Fundamentals of fluid mechanics	1	
4	Flow phenomenon related to vehicles	2	
5	External flow problems.	2	
6	Internal flow problems.	1	
7	Resistance to vehicle motion	1	
8	Performance – Fuel consumption and performance	1	
	<b>UT-I (CO1)</b>		
	<b>UNIT –II</b>	<b>(9)</b>	
9	Bluff body	1	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
10	Flow field around car	1	
11	Drag force	1	
12	Types of drag force	2	
13	Drag force coefficient	1	
14	Analysis of aerodynamic drag	1	
15	Drag coefficient of cars	1	
16	Strategies for aerodynamic development	1	
	<b>MT-I ( CO1, CO2)</b>		
	<b>UNIT-III</b>	<b>(9)</b>	
17	Front end modification	1	Lecture with Discussion/ Demonstration/ Assignment/
18	Front wind shield angle	1	
19	Rear wind shield angle	1	
20	Boat tailing	1	
21	Hatch back,	1	
22	Fast back and square back	1	
23	Dust flow patterns at the rear	1	
24	Effect of gap configuration& Effect of fasteners.	2	
	<b>UT-II (CO3)</b>		
	<b>UNIT IV</b>	<b>(9)</b>	
25	The origin of force and moments on a vehicle	1	Lecture with Discussion/ Demonstration/
26	Side wind problems	1	
27	Methods to calculate forces and moments	1	

<b>S.No</b>	<b>Topics to be covered</b>	<b>No. of periods</b>	<b>Content delivery method</b>
28	Vehicle dynamics Under side winds	1	Tutorial
29	The effects of forces and moments	1	
30	Characteristics of forces and	1	
31	Characteristics of moments	1	
32	Dirt accumulation on the vehicle	1	
33	Wind noise	1	
<b>UNIT V</b>		<b>(9)</b>	
34	Drag reduction in commercial vehicles.	1	Lecture with Discussion/ Demonstration/ Assignment/ Tutorial
35	Introduction – Principles of wind tunnel technology	1	
36	Limitation of simulation	1	
37	Stress with scale models	1	
38	Full scale wind tunnels	1	
39	Measurement techniques	1	
40	Equipment and transducers	1	
41	Road testing methods	1	
42	Numerical methods	1	
<b>MT 2 ( CO3, CO4, CO5)</b>			
<b>Total</b>		<b>45</b>	

## AUTOMOTIVE MATERIALS

LTPC : 3 0 0 3

### 1. Preamble

This course imparts the knowledge on the structure, properties, heat treatment, mechanical property evaluation and applications of ferrous and non-ferrous metals to select the appropriate material for suitable applications.

### 2. Prerequisite

1150PH101	Engineering Physics
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### 3. Links to other courses

- Engine Design and Development
- Vehicle Design and Data Characteristics

### 4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge in properties and structures of solids.
- Acquire the knowledge about various phase diagrams of both ferrous and non-ferrous metals.
- Attain knowledge in heat treatment of steels, properties of non ferrous alloys and evaluate the mechanical properties of different metals.
- Impart the knowledge about the failure mechanism of ductile and brittle materials.

### 5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the different crystallographic structures and crystal imperfection in solids	K2
CO2	Explain the different types of phase diagrams and properties of ferrous and non ferrous metals.	K2
CO3	Apply different heat treatment process in metal industries.	K3
CO4	Distinguish different strengthening mechanism and fracture.	K2
CO5	Interpret the mechanical properties of the given material.	K2

### 6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	L	L				M		M		M	L
CO2	H	H	H	L	L				M		M		M	L
CO3	H	H	H	L	L				M		M		M	L
CO4	H	H	H	L	L				M		M		M	L
CO5	H	H	H	L	L				M		M		M	L

H- High; M-Medium; L-Low

## 7. Course Content

### UNIT I Crystallography

L-9

Classification of Materials, Engineering properties of materials, Structure of Solid materials- BCC- FCC & HCP Structures- Atomic Packing factor- Miller Indices, crystallographic direction, crystallographic Plane, Solid Solution, Types of Solid Solution, Crystal imperfection - point defects, line defects – Edge dislocation, Screw dislocation, surface defects and volume defects.

### UNIT II Ferrous and Non Ferrous Metals and Phase Diagram

L-9

Introduction to Phase Diagram, Gibbs phase Rule, Binary Equilibrium diagram, Isomorphous system - Tie Line Rule and Lever Rule, Iron-Iron carbide Diagram, Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) , Types of steel - HSLA - Maraging steels – TRIP Steels, Tool Steels, Types Stainless Steels —Types of Cast Irons -Copper and its alloys – Aluminum and its alloys.

### UNIT III Heat Treatment

L-9

Importance of Heat Treatment – TTT- Time Temperature Transformation Diagram (Isothermal Transformation diagram), CCT diagram – cooling curves superimposed on I.T. diagram, Types of Heat treatment Processes – different types of Annealing process, Normalizing, Quenching and Tempering of steel. – Hardenability- Grossman’s critical diameter, Jominy end quench test – Austempering, Martempering Case hardening, Carburizing, Nitriding, Cyaniding, Carbonitriding – Flame and Induction hardening.

### UNIT IV Mechanical Properties of Materials & Fracture

L-9

Mechanisms of Plastic and Elastic deformations, Slip and Twinning, Recover Recrystallization and Grain growth- Strengthening Mechanism- Strain hardening, Precipitation hardening, Refinement of Grain, solid solution strengthening, Types of Fracture-, Ductile and Brittle fracture- Griffith’s theory, Creep - Mechanisms of Creep- Creep resistant materials, Fatigue Failure- SN curve- Factors affecting fatigue life, prevention of fatigue failure.

### UNIT V Mechanical Testing

L-9

Tensile test- Stress Strain curves for Ductile and Brittle materials- Mild steel, Copper, Concrete, and Cast iron, Proof Stress, Yield point phenomenon - compression and shear loads, Hardness tests (Brinell, Vicker’s and Rockwell) - Impact test- Izod and Charpy, Fatigue and creep test, Fracture toughness tests.

**Total: 45 Periods**

## 8. Text Books

1. Sidney H. Avner, Introduction to Physical Metallurgy, Tata Mcgraw Hill, 2010.
2. Raghavan V. Physical Metallurgy, Prentice – Hall of India Private Limited, 2<sup>nd</sup> Edition 2006.

## 9. References

- 1 Dieter, G. E., Mechanical Metallurgy, McGraw Hill, Singapore, 2012.
- 2 Thomas H. Courtney, Mechanical Behaviour of Engineering Materials, McGraw Hill, Singapore, 2011.
- 3 William D Callister “Material Science and Engineering”, John Wiley and Sons, 2010.

### 10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 Addressed) (Max marks in %)	II (CO3 & CO4 Addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

### 11. Lecture plan

S.No	Topic	No. of periods	Content Delivery Method
	<b>Unit –I</b>	<b>(9)</b>	
1	Classification of Materials, Engineering properties of materials	1	Lecture with discussions/ Seminar/ Assignment
2	Structure of Solid materials-	1	
3	BCC- FCC & HCP Structures- Atomic Packing factor	1	
4	Miller Indices, crystallographic direction, crystallographic Plane	1	
5	Solid Solution, Types of Solid Solution	1	
6	Crystal imperfection	1	
7	point defects, line defects	1	
8	Edge dislocation, Screw dislocation	1	
9	surface defects and volume defects	1	
	<b>UT-I (CO1)</b>		
	<b>Unit –II</b>	<b>(9)</b>	
10	Introduction to Phase Diagram	1	Lecture with discussions/ Assignment
11	Gibbs phase Rule, Binary Equilibrium diagram	1	
12	Isomorphus system - Tie Line Rule and Lever Rule	1	
13	Iron-Iron carbide Diagram	1	
14	Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W)	1	
15	Types of steel - HSLA - Maraging steels	1	
16	TRIP Steels, Tool Steels, Types Stainless Steels	1	



S.No	Topic	No. of periods	Content Delivery Method
17	Types of Cast Irons -Copper and its alloys	1	Seminar/ Assignment
18	Aluminum and its alloys	1	
<b>MT-I ( CO1, CO2)</b>			
	<b>Unit-III</b>	<b>(9)</b>	
19	Importance of Heat Treatment	1	Lecture with discussions/ Seminar/ Assignment
20	TTT- Time Temperature Transformation Diagram (Isothermal Transformation diagram)	2	
21	CCT diagram – cooling curves superimposed on I.T. diagram	1	
22	Types of Heat treatment Processes	1	
23	Annealing process, Normalizing, Quenching and Tempering of steel	1	
24	Hardenability - Grossman's critical diameter, Jominy end quench test	1	
25	Austempering, Martempering	1	
26	Case hardening, Carburising, Nitriding, Cyaniding, Carbonitriding – Flame and Induction hardening	1	
<b>UT-II (CO3)</b>			
	<b>Unit IV</b>	<b>(9)</b>	
27	Mechanisms of Plastic and Elastic deformations, Slip and Twinning	2	Lecture with discussions/ Seminar/ Assignment
28	Recover Recrystallization and Grain growth	1	
29	Strengthening Mechanism- Strain hardening	1	
30	Precipitation hardening, Refinement of Grain, solid solution strengthening	1	
31	Types of Fracture-, Ductile and Brittle fracture	1	
32	Griffith's theory, Creep	1	
33	Mechanisms of Creep- Creep resistant materials	1	
34	Fatigue Failure- SN curve	1	
35	Factors affecting fatigue life, prevention of fatigue failure	1	
	<b>Unit V</b>	<b>(9)</b>	
35	Tensile test- Stress Strain curves for Ductile and Brittle materials	1	Lecture with discussions/ Seminar/ Assignment
36	Mild steel, Copper	1	
37	Concrete, and Cast iron	1	
38	Proof Stress, Yield point phenomenon	1	
39	Compression and shear loads	1	
40	Hardness tests (Brinell, Vicker's and Rockwell)	1	
41	Impact test- Izod and Charpy	1	
42	Fatigue and creep test	1	
43	Fracture toughness tests	1	
<b>MT 2 ( CO3, CO4, CO5)</b>			
<b>Total</b>		<b>45</b>	

**1. Preamble**

Students undergoing this course are expected to gain knowledge on testing and certification of passenger vehicles and its component.

**2. Pre-requisite**

NIL

**3. Links to Other Courses**

NIL

**4. Course Educational Objectives**

Students undergoing this course are expect to

- To understand the vehicle classifications, regulations and need for certification
- To learn the various static & dynamic test to be done on vehicle
- To impart knowledge about the various tests performed on engine

**5. Course Outcomes**

Upon the successful completion of the course, learners will be able to

<b>CO Nos.</b>	<b>Course Outcomes</b>	<b>Level of learning domain (Based on revised Bloom's)</b>
C01	Classify the vehicle and identify the regulations governing for each vehicle type	K2
C02	Perform and analyze the Static & Dynamic test of any vehicle	K2
C03	Perform various test related to vehicle engine emissions	K2
C04	Test and analyze the performance of vehicle components	K2
C05	Perform the tests to be done on the vehicle lighting system	K2

**6. Correlation of COs with Programme Outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
CO1	H	H	H	H	M	L		L	L		M	L	M	L
CO2	H	H	H	H	M	L		L	L		M	L	M	L
CO3	H	H	H	H	M	L		L	L		M	L	M	L
CO4	H	H	H	H	M	L		L	L		M	L	M	L
CO5	H	H	H	H	M	L		L	L		M	L	M	L

H- Strong; M-Medium; L-Low

**7. Course contents**

**UNIT I Introduction**

**L-9**

Specification & Classification of Vehicles (including M, N and O layout), Homologation & its Types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks.

**UNIT II Static Testing of Vehicle**

**L-9**

Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls For M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement of Temporary Cabin For Drive – Away - Chassis.

**UNIT III Dynamics Testing of Vehicle****L-9**

Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test. Engine power test (petrol & diesel), Indian driving cycle, Vehicle mass emission, Evaporative emission (petrol vehicles).

**UNIT IV Vehicle Component Testing****L-9**

Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion, Crash test with dummies, Demist test, Defrost Test, Interior Fittings, Steering Impact test (GVW<1500 kg), Body block test, Head form test, Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints test, Airbag Test, Accelerator Control System.

**UNIT V Vehicle Lighting Testing****L-9**

Installation requirement for lighting, signaling & reflective devices Installation, Conspicuity & Reflective Marking, Photometry Test: Performance requirement for lighting, signaling and reflective devices - Head lamp, Front lamp, direction indicator lamp, signaling lamp and Warning triangles.

**Total: 45 Periods****8. Text Books**

1. Vehicle Inspection Handbook by American Association of Motor Vehicle Administrators
2. Michael Plint & Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmann, 3rd edition, 2007

**9. References**

1. Proceedings- Automotive Testing & Certification held on 20<sup>th</sup> to 24<sup>th</sup> July 2010 at ARAI, Pune
2. Bosch Automotive Handbook
3. Motor Vehicle Manual
4. BIS & AIS
5. ECE
6. EEC
7. FMVSS
8. CMVR

### 10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember	10	20
Understand	90	80
Apply		
Analyse		
Evaluate		
Create		

### 11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
<b>Unit –I</b>		<b>(9)</b>	
1	Specification & Classification of Vehicles (including M, N and O layout)	2	Lecture with discussions/ Seminar/ Assignment
2	Homologation & its Types	1	
3	Regulations overview (EEC, ECE, FMVSS, AIS, CMVR)	2	
4	Type approval Scheme, Homologation for export	1	
5	Conformity of Production	2	
6	Various Parameters, Instruments and Types of test tracks	1	
<b>UT-I (CO1)</b>			
<b>Unit –II</b>		<b>(9)</b>	
7	Photographs, CMVR physical verification	1	Lecture with discussions/ Seminar/ Assignment
8	Tyre Tread Depth Test, Vehicle Weightment	1	
9	Horn installation, Rear view mirror installation	2	
10	Tell Tales, External Projection, Wheel Guard	1	
11	Arrangement of Foot Controls For M1 Vehicle	1	
12	Angle & Dimensions Measurement of Vehicle	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
13	The Requirement Of Temporary Cabin For Drive – Away - Chassis	2	
	<b>MT-I ( CO1, CO2)</b>		
	<b>Unit-III (9)</b>		
14	Hood Latch, Gradeability, Pass-by Noise, Interior Noise	1	Lecture with discussions/ Seminar/ Assignment
15	Turning Circle Diameter & Turning Clearance Circle Diameter	1	
16	Steering Effort, Constant Speed Fuel Consumption	1	
17	Cooling Performance, Speedo-meter Calibration	1	
18	Range Test, Maximum Speed, Acceleration Test, Coast-down test	1	
19	Brakes Performance ABS Test, Broad band / Narrow band EMI Test	2	
20	Engine power test (petrol & diesel), Indian driving cycle	1	
21	Vehicle mass emission, Evaporative emission (petrol vehicles)	1	
	<b>UT-II (CO3)</b>		
	<b>Unit IV (9)</b>		
22	Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test	1	Lecture with discussions/ Seminar/ Assignment
23	Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test	2	
24	Tyre & Wheel Rim Test, Bumper Impact Test, Side Door Intrusion	1	
25	Crash test with dummies, Demist test, Defrost Test, Interior Fittings	1	
26	Steering Impact test (GVW<1500 kg), Body block test, Head form test	1	
27	Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages	1	
28	Seat anchorages & head restraints test	1	
29	Airbag Test, Accelerator Control System	1	
	<b>Unit V (9)</b>		
30	Installation requirement for lighting, signaling & reflective devices Installation,	2	Lecture with discussions/ Seminar/
31	Conspicuity & Reflective Marking,	2	
32	Photometry Test: Performance requirement for lighting, signaling and reflective devices	2	
33	Head lamp, Front lamp, direction indicator lamp, signaling lamp and Warning triangles	3	
	<b>MT – II ( CO3, CO4, CO5)</b>		
	<b>Total</b>	<b>45</b>	

## ENGINE DESIGN AND DEVELOPMENT

LTPC : 2 2 0 3

### 1. Preamble

This course enables the students to appreciate the different requirements, design principles and procedures involved in automotive design. It helps the students to speculate and verify different design possibilities to meet the customer requirements. It develops the ability in understanding the technical requirements and feasibilities while designing and manufacturing automotive components.

### 2. Pre-requisite

1151AU107	I.C Engines
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### 3. Links to other Courses

- Vehicle Design & Data Characteristics

### 4. Course Educational Objectives

Students undergoing this course are expected to

- Analyze and evaluate the different requirements of the crank train components to meet the functional needs.
- Develop the skill of designing different engine components to meet the requirements in the perspective of material, manufacturing technology.
- Apply the different engineering facts, concepts and procedures in accordance with the engine design requirement.

### 5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
C01	Describe the various engine performance parameters	K2
C02	Construct crank train for the given specifications which includes the design of piston, connecting rod, crankshaft and flywheel	K3
C03	Calculate thermal loads and select a suitable material to design cylinder head and block	K3
C04	Select and design suitable valve train for the given specifications.	K3
C05	Describe the design procedure involved in Cooling, Lubrication, Intake, Exhaust and Fuel Injection Systems	K2

### 6. Correlation with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L	H							M	L
CO2	H	H	H	M	L	H							M	L
CO3	H	H	H	M	L	H							M	L
CO4	H	H	H	M	L	H							M	L
CO5	H	H	H	M	L	H							M	L

H- Strong; M-Medium; L-Low

## **7. Course content**

### **UNIT I- Parameters**

**L-6;T-3**

Compression ratio, Pressure volume and pressure crank angle diagram, frictional mean effective pressure, engine capacity, calculation of bore and stroke length, velocity and acceleration, gas force, inertia and resultant force at various crank angles – Side thrust on cylinder walls, Optimization criteria for improving Thermal, Mechanical and Volumetric efficiency.

### **Unit 2: Design of Crank Train**

**L-6;T-3**

Design of Piston, piston rings, piston pin, Design of connecting rod; big end, small end and shank. Material and failures related to Cylinder, piston, connecting rod, design of crankshaft for light and heavy vehicle; Crankshaft, front end, rear end, journals, crank pin, Crank web. Design of flywheel; Speed fluctuation and stress calculations, turning moment diagram, design of hub, rim and arms of the flywheel, Ring gear Material and failures related to Crankshaft and flywheel.

### **Unit 3 Design of cylinder Head and block**

**L-6;T-3**

Functional requirement, Block material like Gray Iron, Aluminum, Compacted Graphite Iron and Magnesium, Cylinder head alloys, Design layout, Basic block, Bulk head design, and Cylinder liner design approach and Thermal loads. Cylinder arrangement, number of cylinders,

### **Unit 4 Design of valve train**

**L-6;T-3**

Effect of valve timing on engine performance, Number of Valves, Design of valves, Valve seat, Valve guide and cotter. Time selection of valve, Cam profile construction, Design of valve spring, Design of camshaft, Single and Double Overhead camshaft design, Design of valve gear train for variable valve timing.

### **Unit 5 Cooling, Lubrication, Intake, Exhaust and Fuel Injection Systems**

**L-6;T-3**

Design of cooling system, radiator, water pump, thermostat and fan, Computation of air cooling system Engine friction and wear, Selection of lubricant, lubricating system, pump and filters, Design of intake and exhaust system ,Design of fuel system for CI engine, Governor Design, Design of carburetor, Design of MPFI, GDI, CRDI system.

**TOTAL: (30+15) 45 Periods**

## **8. Text Books**

1. Kevin L. Hoag ,”Vehicular Engine Design”,SAE international,2005.
2. A.Kolchin and V.Demidov, “Design of Automotive Engines”, MIR Publishers, Moscow,1984.
3. R.K. Jain, “Machine Design”, Khanna Publishers, New Delhi, 1997.

## **9. Reference Books**

1. “Design Data Book”, PSG College of Technology, Coimbatore, 2000.
2. Engine Design – Giles J. G., Liffle Book Ltd.
3. Engine Design – Crouse, Tata McGraw Publication, Delhi

### 10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	10			10
Understand	80	50	40	40	30
Apply		50	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
<b>Remember</b>		
<b>Understand</b>	40	40
<b>Apply</b>	60	60
<b>Analyse</b>		
<b>Evaluate</b>		
<b>Create</b>		

### 11. Lecture plan

S.No	Topics to be covered	No. of periods	Content delivery method
1	<b>UNIT –I</b>	<b>(9)</b>	
2	Compression ratio, Pressure volume and pressure crank angle diagram	2	Lecture with Discussion /Assignment/ Seminar
3	Frictional mean effective pressure, engine capacity	1	
4	Calculation of bore and stroke length	2	
5	Velocity and acceleration	1	
6	Gas force, inertia and resultant force at various crank angles	2	
7	Side thrust on cylinder walls	1	
	<b>UT-I (CO1)</b>		
	<b>UNIT –II</b>	<b>(9)</b>	
8	Design of piston rings, piston pin	1	Lecture with Discussion/ Demonstration/ Assignment
9	Design of connecting rod; big end, small end and shank	1	
10	Material and failures related to Cylinder, piston, connecting rod	1	
11	Design of crankshaft for light and heavy vehicle	1	
12	Crankshaft, front end, rear end, journals, crank arm	1	
13	Design of flywheel; Speed fluctuation and stress calculations, turning moment diagram	2	



S.No	Topics to be covered	No. of periods	Content delivery method
14	Design of hub, rim and arms of the flywheel	1	
15	Material and failures related to Crankshaft and flywheel	1	
	<b>MT-I ( CO1, CO2)</b>		
	<b>UNIT-III</b>	<b>(9)</b>	
16	Functional requirement, Block material like Gray Iron, Aluminum	2	Lecture with Discussion/ Assignment/
17	Compacted Graphite Iron and Magnesium, Cylinder head alloys	2	
18	Design layout, Basic block, Bulk head design	2	
19	Cylinder liner design approach and Thermal loads	2	
20	Cylinder arrangement, number of cylinders	1	
	<b>UT-II (CO3)</b>		
	<b>UNIT IV</b>	<b>(9)</b>	
21	Effect of valve timing on engine performance	1	Lecture with Discussion/ Demonstration
22	Time selection of valve	1	
23	Cam profile construction	1	
24	Design of valve spring	2	
25	Design of camshaft	2	
26	Design of valve gear train for variable valve opening	2	
	<b>UNIT V</b>	<b>(9)</b>	
27	Design of cooling system, radiator, water pump and fan	2	Lecture with Discussion/ Assignment
28	Computation of air cooling system Engine friction and wear	1	
29	Selection of lubricant, lubricating system, pump and filters	1	
30	Design of intake and exhaust system	1	
31	Design of fuel system for CI engine, Governor Design	1	
32	Design of carburetor	1	
33	Design of direct cylinder and port injection system for SI engine	2	
	<b>MT 2 ( CO3, CO4 &amp; CO5)</b>		
	<b>Total</b>	<b>45</b>	

**OFF HIGHWAY VEHICLES****LTTC : 3 0 0 3****1. Preamble**

This course imparts knowledge in the vehicles used for agriculture, army and construction purposes and earth movers.

**2. Prerequisite**

NIL

**3. Links to other Courses**

Automotive chassis, vehicle body engineering

**4. Course Educational Objectives**

Students undergoing this course are expected to:

- Gain knowledge about the vehicles used in agriculture, mining and construction.
- Gain knowledge about the working of different systems in special vehicles.

**5. Course Outcomes**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the different types of cranes and compactors used in market and would be in position to select and discuss the right type for the given application	K2
CO2	Explain the different types of excavator and graders, further, would be able to enumerate and explain the different sub systems	K2
CO3	Describe the construction and working of haulage vehicle and lift trucks in the perspective of their applications	K3
CO4	Describe the specifications, functions, merits and demerits of different types and subsystems of rotozers, scarifiers and scrapers	K2
CO5	Explain the different types of tractors and other special vehicles in the perspective of different types, application, requirement and availability in the market	K2

(K2 – Understand; K3 – Apply)

**6. Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	L	H		L	L						M	L
CO2	M	H	L	H		L	L						M	L
CO3	M	H	L	H		L	L						M	L
CO4	M	H	L	H		L	L						M	L
CO5	M	H	L	H		L	L						M	L

H- High; M-Medium; L-Low

## 7. Course Content

### UNIT I CRANES & COMPACTION VEHICLES

L-9

CRANES: General description, specifications and functions, excavator mounted cranes, mobile cranes with strut and cantilever type jibs, tractor towed and tractor mounted cranes. COMPACTION VEHICLES: General description, specification and functions, smooth wheeled rollers, pneumatic tired rollers, agricultural Rollers, sheep's foot rollers; vibrating compactors.

### UNIT II EXCAVATORS & GRADERS

L-9

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

GRADERS: Description, specification of tractor towed graders and motor graders, classification and functions of graders, functional details of spreading, mixing, ditching, bank sloping, snow removal, stripping, scarifying, and finishing, elementary details of transmission system (coupling, clutches, gear box, driving axles, propeller shafts), running gear and operating equipment air braking system; hydraulic system and its components, steering system of lights, medium and heavy graders, merits and limitations of graders.

### UNIT III HAULAGE VEHICLES & LIFT TRUCKS

L-9

HAULAGE VEHICLES: General description, specification and functions, self-propelled and tractor towed haulage vehicles and pneumatic – tires, dumpers – front tipping; trucks – rear tipping, tractor towed semi-trailers and trailers (rear and side tipping, bottom dumping). 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.

### UNIT IV ROOTERS AND SCARIFIERS & SCRAPERS

L-9

ROOTERS AND SCARIFIERS: General description, specification and functions, tractor towed rooters and scarifiers {heavy duty (roller)/ light duty (grader)} back rippers for bull and angle dozers.

SCRAPERS: General description, specification and functions, tractor towed and motorized scrapers, scraper work in cutting, cambering, side hill cutting, spreading on embankments, compaction of fill merits and demerits.

### UNIT V TRACTORS & OTHER SPECIAL PURPOSE VEHICLES

L-9

TRACTORS: General description, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled-bull dozers, tilt dozers and angle dozers, front end loaders, factors affecting efficiency of output of tractors, simple problems, merits and demerits. OTHER SPECIAL PURPOSE VEHICLES: Mining and surveillance General description, specification and functions, Ambulance, Oil tankers, surveillance vehicle, Television recording Mobile, Reefer vehicle, Double Decker bus, Vestibule bus, Fire fighting vehicle

**Total: 45 Periods**

## 8. Text Books :

1. Ian Andrew Norman, "Heavy Duty Vehicle systems", third edition, Delmar-Thomson Learning Ltd.
2. Robert L Peurifoy, "Construction, planning, equipment and methods" Tata McGraw Hill Publishing company Ltd.
3. Nakra C.P., "Farm machines and equipments" Dhanparai Publishing company Pvt. Ltd

## 9. References :

1. Her Majesty's Stationery, "Military Engineering – Volume 26".
2. Heinz Heisler, "Vehicle and Engine Technology" second edition, SAE-1999, USA.
3. SAE Handbook Vol. III., Society of Automotive Engineers, 1997

## 10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1(CO1 &CO2) (Max marks in %)	2(CO3&CO4) (Max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

## 11. Lecture plan:

S.No	Topics to be covered	No. of periods	Content Delivery Method
	<b>Unit –I (9)</b>		
1	Cranes: General description, specifications and functions,	1	Lecture with discussions/ Seminar/ Assignment
2	Excavator mounted cranes	1	
3	Mobile cranes with strut and cantilever type jibs	1	
4	Tractor towed and tractor mounted cranes	1	
5	Compaction Vehicles: General description, specification and functions	1	
6	Smooth wheeled rollers	1	
7	Pneumatic tired rollers	1	
8	Agricultural rollers,	1	
9	Sheep's foot rollers ; vibrating compactors	1	
	<b>UT-I (CO1)</b>		
	<b>Unit –II (9)</b>		
10	Excavators: General description, specification and functions	1	Lecture with discussions/

S.No	Topics to be covered	No. of periods	Content Delivery Method
11	Classification based on attachments, face shovel	1	Seminar/ Assignment
12	Drag shovel, hoe, drag-line, Grab or clam shell, advantages and limitations.	1	
13	GRADERS: Description, specification of tractor towed graders and motor graders	1	
14	Classification and functions of graders, functional details of spreading, mixing, ditching	1	
15	Bank sloping, snow removal, stripping, scarifying, and finishing,	1	
16	Elementary details of transmission system (coupling, clutches, gear box, driving axles, propeller shafts),	1	
17	Running gear and operating equipment air braking system; hydraulic system and its components	1	
18	Steering system of lights, medium and heavy graders, merits and limitations of graders	1	
<b>MT-I ( CO1, CO2)</b>			
	<b>Unit-III</b>	<b>(9)</b>	
19	Haulage Vehicles: General description, specification and functions	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
20	Self-propelled and tractor towed haulage vehicles	1	
21	Pneumatic – tires, dumpers – front tipping	1	
22	Trucks – rear tipping,	1	
23	Tractor towed semi-trailers	1	
24	Trailers (rear and side tipping, bottom dumping). LIFT	1	
25	Trucks: General description, specification and functions,	1	
26	Fork lift trucks, alternative front end equipment (attachments) – jib arm, shovel bucket, squeeze clamp, boom	1	
27	Fork extensions, barrel forks. Scissors lift trucks - applications in industry, advantages and disadvantages	1	
<b>UT-II (CO3)</b>			
	<b>Unit IV</b>	<b>(9)</b>	
28	Rooters and scarifiers: General description, specification and functions,	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
29	Tractor towed rooters	1	
30	Scarifiers {heavy duty (roller)/ light duty (grader)}	1	
31	Back rippers for bull and angle dozers.	1	
32	Scrapers: General description, specification and functions,	1	
33	Tractor towed and motorized scrapers,	1	
34	Scraper work in cutting, cambering,	1	
35	Side hill cutting, spreading on embankments	1	
36	Compaction of fill merits and demerits	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
	<b>Unit V</b>	<b>(9)</b>	
37	Tractors: General description, specification and functions,	1	Lecture with discussions/ Seminar/ Lecture with demonstration
38	Light, medium and heavy wheeled tractors,	1	
39	Crawler tracks mounted / wheeled-bull dozers, tilt dozers and angle dozers, front end loaders,	1	
40	Factors affecting efficiency of output of tractors, simple problems, merits and demerits.	1	
41	Other special purpose vehicles: General description, specification and functions	1	
42	Ambulance, Oil tankers surveillance vehicle	1	
43	Television recording Mobile	1	
44	Reefer vehicle, Double Decker bus	1	
45	Vestibule bus, Fire fighting vehicle	1	
	<b>MT – II ( CO3, CO4, CO5)</b>		
	<b>Total</b>	<b>45</b>	

## VEHICLE BODY ENGINEERING

LTPC : 3 0 0 3

### 1. Preamble

This course imparts knowledge in the construction of vehicles, concept aerodynamics, and different types of car and passenger bus bodies.

### 2. Pre-requisite

NIL

### 3. Links to other courses

- Vehicle Design & Data Characteristics
- Automotive Chassis
- I.C Engines
- Automotive Safety

### 4. Course Educational Objectives

Students undergoing this course are expected

- To develop the basic knowledge of the students in design of the vehicle body to give maximum comfort for the passengers and exposed to the methods of stream lining the vehicle body to minimize drag.
- To develop the skills of the students in the areas of car body design, bus body design, active and passive safety.

### 5. Course outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the different types of car body design and its safety features.	K2
CO2	Select a suitable body optimization techniques to minimize drag and able to describe the wind tunnel testing procedure.	K2
CO3	Classify the various types of bus body construction and able to identify the body layout.	K2
CO4	Describe the different types of commercial vehicles and its design.	K2
CO5	Explain the various types of materials and painting techniques used in automobiles.	K2

### 6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	H			L				L		M	L
CO2	H	H	M	H			L				L		M	L
CO3	H	H	M	H			L				L		M	L
CO4	H	H	M	H			L				L		M	L
CO5	H	H	M	H			L				L		M	L

H- High; M-Medium; L-Low

## 7. Course content

### UNIT I Car Body

L-9

Types: saloon, convertibles, limousine, estate car, racing and sports car. Visibility: regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars. Safety: safety design, safety equipments for cars. Car body construction; design criteria, prototype making, initial tests, crash tests on full scale model, Dummies and Instrumentation

### UNIT II Vehicle Aerodynamics

L-9

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 tunnel testing: flow visualization techniques, scale model testing, component balance to measure forces and moments.

### UNIT III Bus Body

L-9

Types: mini bus, single decker, double-decker, two level and articulated bus. Bus body layout: floor height, engine location, entrance and exit location, seating dimensions. Constructional details: frame construction, double skin construction, types of metal sections used, Regulations, Conventional and integral type construction.

### UNIT IV Commercial Vehicle

L-9

Types of body: flat platform, drop side, fixed side, tipper body, tanker body and Haulage vehicle. Light commercial vehicle body types. Dimensions of driver's seat relation to controls. Drivers cab design.

### UNIT V Body Materials, Trim and Mechanisms

L-9

Steel sheet, timber, plastic, GRP, properties of materials; Corrosion, anticorrosion methods. Selection of paint and painting process. Body trim items. Body mechanisms.

**TOTAL: 45 periods**

## 8. Text Books

1. J.Powloski - "Vehicle Body Engineering" - Business Books Ltd, London -1989

## 9. References

1. Giles.J.C.- "Body construction and design"- Liiffe Books Butterworth & Co. - 1971.
2. John Fenton - "Vehicle Body layout and analysis" - Mechanical Engg. Publication Ltd., London – 1982.
3. Braithwaite.J.B. - "Vehicle Body building and drawing" - Heinemann Educational Books Ltd., London – 1977.

## 10. Revised Bloom's based Assessment Pattern :

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	60	60	60	80
Apply					
Analyse					
Evaluate					
Create					



Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember	20	10
Understand	80	90
Apply		
Analyse		
Evaluate		
Create		

### 11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
<b>Unit –I</b>		<b>(9)</b>	
1	Types: saloon, convertibles, limousine, estate car, racing and sports car	1	Lecture with discussions/ Seminar/ Assignment
2	Visibility: regulations, driver's visibility	1	
3	Tests for visibility	1	
4	Methods of improving visibility and space in cars	1	
5	Safety: safety design, safety equipments for cars	1	
6	Car body construction; design criteria, prototype making, initial tests	2	
7	Crash tests on full scale model	1	
8	Dummies and Instrumentation	1	
<b>UT-I (CO1)</b>			
<b>Unit –II</b>		<b>(9)</b>	
9	Objectives, Vehicle drag and types	1	Lecture with discussions/ Seminar/ Assignment
10	Various types of forces and moments	1	
11	Effects of forces and moments	1	
12	Side wind effects on forces and moments	1	
13	Various body optimization techniques for minimum drag	2	
14	Wind tunnel testing: flow visualization techniques	1	
15	Scale model testing	1	
16	Component balance to measure forces and moments	1	
<b>MT-I (CO1, CO2)</b>			
<b>Unit-III</b>		<b>(9)</b>	
17	Types: mini bus, single decker, double-decker, two level and articulated bus	2	Lecture with discussions/ Seminar/ Assignment
18	Bus body layout; floor height, engine location, entrance and exit location, seating dimensions	2	
19	Constructional details: frame construction, double skin construction	2	
20	Types of metal sections used, Regulations	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
21	Conventional and integral type construction	2	
	<b>UT-II (CO3)</b>		
	<b>Unit IV</b>	<b>(9)</b>	
22	Types of body; flat platform, drop side, fixed side	2	Lecture with discussions/ Seminar/ Assignment
23	Tipper body, tanker body and Haulage vehicle	2	
24	Light commercial vehicle body types	2	
25	Dimensions of driver's seat relation to controls	1	
26	Drivers cab design	2	
	<b>Unit V</b>	<b>(9)</b>	
27	Steel sheet, timber, plastic, GRP	2	Lecture with discussions/ Seminar
28	Properties of materials	1	
29	Corrosion, anticorrosion methods	2	
30	Selection of paint and painting process	2	
31	Body trim items.Body mechanisms	2	
	<b>MT – II ( CO3, CO4, CO5)</b>		
	<b>Total</b>	<b>45</b>	

**STRUCTURAL & VEHICLE DYNAMICS**

LTPC : 2 2 0 3

**1. Preamble**

This course enriches knowledge of the learners in analyzing forces and moments exerted in vehicle under different loads, speed and road conditions in order to improve the comfort for the passengers and life of the various components of the vehicle.

**2. Pre-Requisite**

1151ME101	Engineering Mechanics
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**3. Links to Other Courses**

- Finite element analysis
- Vehicle Design and Data Characteristics

**4. Course Educational Objectives**

- To develop the basic knowledge of the students in automotive field in the areas of vehicle vibrations.
- To develop the skills of the students in stability of vehicles and their effects, related with longitudinal, vertical & lateral dynamics.

**5. Course Outcomes**

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basics of vibration, when the vehicle is at dynamic condition.	K2
CO2	Understand the tyre dynamics with respect to force & moments.	K2
CO3	Derive the effective cornering stiffness when considering the elastic elements in the wheel suspension and be able to analyze effect on the dynamic characteristics of the vehicle	K3
CO4	Understand the aerodynamic forces & moments, load distribution in the various vehicles.	K2
CO5	Test the effective steering geometry, vehicle handling & directional control of vehicle	K3

**6. Correlation of COs with Programme Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	H	H	L	L						L	M	L
CO2	H	M	H	H	L	L							M	L
CO3	H	M	H	H	L	L				L	L		M	L
CO4	H	M	H	H	L	L							M	L
CO5	H	M	H	H	L	L				H	H		M	L

H- High; M-Medium; L-Low

## 7. Course Content

### UNIT I CONCEPT OF VIBRATION

L-9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

### UNIT II TIRE DYNAMICS

L-9

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire road friction. Test on Various road surfaces. Tire vibration.

### UNIT III VERTICAL DYNAMICS

L-9

Human response to vibration, Sources of Vibration. Design and analysis of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties.

### UNIT IV LONGITUDINAL DYNAMICS

L-9

Aerodynamic forces and moments. Equation of motion. Resistance, rolling resistance, Load distribution for three wheeler and four wheeler. Calculation of Maximum acceleration, Reaction forces for different drives. Braking and Driving torque. Prediction of Vehicle performance.

### UNIT V LATERAL DYNAMICS

L-9

Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles .Roll center, Roll axis, Vehicle under side forces. Stability of vehicle running on slope, banked road and during turn, Effect of suspension on cornering, latest trends in Vehicle dynamic testing like four poster, Multi axis simulator, etc.

**TOTAL: 45 Periods**

## 8. Text Books

1. Singiresu S. Rao, "Mechanical Vibrations", 5 th Edition, Prentice Hall, 2010
2. Wong. J. Y., "Theory of Ground Vehicles", 3rd Edition, Wiley-Interscience, 2001
3. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005
4. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992

## 9. References

1. Dean Karnopp, "Vehicle Stability", 1st edition, Marcel Dekker, 2004
2. NakhaieJazar. G., "Vehicle Dynamics: Theory and Application", 1st edition, Springer, 2008
3. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited 2004
3. Hans B Pacejka, "Tire and Vehicle Dynamics", 2nd edition, SAE International, 2005 65
4. John C. Dixon, "Tires, Suspension, and Handling", 2nd edition, Society of Automotive Engineers Inc, 1996 6. Jan Zuijdijk, "Vehicle dynamics and damping", Author House, 2009

## 10. Revised Bloom's based Assessment Pattern

	<b>Internal</b>	<b>University</b>
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Revised Bloom's Category	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	Examination (%)
Remember	20	20	10	20	20
Understand	80	40	40	50	50
Apply		40	50	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand	40	50
Apply	60	50
Analyse		
Evaluate		
Create		

#### 11. Lecture plan:

S.No.	Topic	No. of periods	Content delivery method
	<b>Unit –I</b>	<b>(9)</b>	Lecture with Discussion/ Assignment/ Seminar
1	Single degree of freedom, two degree of freedom	2	
2	Free, forced and damped vibrations, modelling and simulation studies	2	
3	Model of an automobile, magnification.	2	
4	Factor, transmissibility, vibration absorber	3	
	<b>UT-I (CO1)</b>		
	<b>Unit –II</b>	<b>(9)</b>	Lecture with Discussion/ Assignment
5	Requirements of suspension system.	1	
6	Spring mass frequency, wheel hop, Wheel wobble, wheel shimmy,	1	
7	Choice of suspension spring rate. Calculation of effective spring rate.	1	
8	Vehicle suspension in fore and aft & roll axis. Human response to vibration, vehicle ride model.	2	
9	Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tyres	2	
10	Cornering properties of tyres, ride properties of tyre	2	
	<b>MT-I (CO1, CO2)</b>		
	<b>Unit-III</b>	<b>(9)</b>	

S.No.	Topic	No. of periods	Content delivery method
11	Load distribution, and, and reactions for different drives.	3	Lecture with Discussion
12	stability on a curved track slope	3	
13	banked road calculation of tractive effort	3	
	<b>UT-II (CO3)</b>		
	<b>Unit IV</b>	<b>(9)</b>	
14	Equation of motion and maximum tractive effort. Aerodynamics forces and moments	2	Lecture with Discussion/ Assignment/ Seminar / Tutorial
15	Power plant and transmission characteristics. Prediction of vehicle performance.	2	
16	Braking performance. Steering geometry. Steady state handling characteristics.	2	
17	Steady state response to steering input. Transient response characteristics.	2	
18	Directional stability of vehicle.	1	
	<b>Unit V</b>	<b>(9)</b>	
19	Objects — Vehicle types of drag. Various types of forces and moments.	2	Lecture with Discussion
20	Effects of forces and moments. Various body optimization techniques for minimum drag.	3	
21	Principle of wind tunnel technology. Flow visualization techniques.	2	
22	Test with scale models.	3	
	<b>MT-II ( CO3, CO4, CO5)</b>		
	<b>Total</b>	<b>45</b>	

**1. Preamble**

This course imparts understanding of role of safety systems in automobiles through technology.

**2. Pre-Requisite**

1150EC101	Basic Electronics Engineering
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**3. Links to Other Courses**

- Vehicle Body Engineering
- Automotive chassis

**4. Course Educational Objectives**

Students undergoing this course are expected to

- Gain knowledge about the vehicles structural crashworthiness and crash testing
- Gain knowledge about the working of vehicle vision safety systems

**5. Course Outcomes:**

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identity different safety systems and vehicle structural crashworthiness	K2
CO2	Analyse and simulate vehicle in barrier impacts	K2
CO3	Design vehicle safety systems	K3
CO4	Determine the fundamentals of light ,vision and colour	K2
CO5	Analyse pedestrian safety by use of light measurement and testing	K3

**6. Correlation of COs with Programme Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	L	H		L	L						M	L
CO2	H	H	L	H		L	L						M	L
CO3	H	H	L	H		L	L						M	L
CO4	H	H	L	H		L	L						M	L
CO5	H	H	L	H		L	L						M	L

H- High; M-Medium; L-Low

**7. Course Content****UNIT I Introduction vehicle safety, structural crashworthiness and crash testing L-6**

Automotive Safety-Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology. Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests

**UNIT II Ergonomics and human response to impact**

L-6

Importance of Ergonomics in Automotive safety, Locations of controls, Anthropometry, Human impact tolerance Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria's and relation with crash and modeling and simulation studies in dummy

### **UNIT III Vehicle safety systems**

**L-6**

Survival space requirements, Restraints systems used automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, Hinges and latches etc. Active safety

### **UNIT IV Fundamentals of light, vision and colour**

**L-6**

Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light, Measures of radiation and light, standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system visual processing, lighting for results, modes of appearance, Pointers for lighting devices. Nature of the color Tri-chromatic Colorimetry, Surface color, color spaces and color solids,, color rendering.

### **UNIT V Light Measurements, Testing equipment, calibration and photometric practice**

**L-6**

Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio- Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure

**Total: 30 Periods**

### **8. Text Books:**

1. Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996
2. Jullian Happian-Smith 'An Introduction to Modern Vehicle Design' SAE, 2002
3. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995
4. Edward .A, Lamps and Lighting, Hodder & Stoughton, London, 1993.
5. Bosch –automotive -handbook ,edition 5-SAE Publication-2000

### **9. References:**

1. Keitz H. A. E, Light calculations and Measurements, Macmillan, 1971.
2. Olson L. P, Forensic aspects of driver perception and response, Lawyers and Judges 1996.
3. Pantazis. M, Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.
4. Matthew Huang, "Vehicle Crash Mechanics".
5. David C. Viano, "Role of the Seat in Rear Crash Safety".
6. Jeffrey A. Pike, "Neck Injury".
7. Ching-Yao Chan, "Fundamentals of Crash Sensing in Automotive Air Bag Systems".
8. Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics and Human Factors", SAE Special Publication, November 2003.





### 10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2) (Max marks in %)	II (CO3 & CO4) (Max marks in %)
Remember	20	20
Understand	80	80
Apply		
Analyse		
Evaluate		
Create		

### 11. Lecture plan

S.No.	Topics to be covered	No. of periods	Content delivery method
	<b>Unit –I</b>	<b>(6)</b>	
1	Design of the body for safety, energy equation, engine location	1	Lecture with discussion/ Assignment/ Seminar
2	Deceleration of vehicle inside passenger compartment	1	
3	Deceleration on impact with stationary and movable obstacle	2	
4	Concept of crumple zone	2	
	<b>UT-I (CO1)</b>		
	<b>Unit –II</b>	<b>(6)</b>	
5	Active safety: driving safety, conditional safety, perceptibility safety,	1	Lecture with discussion/ Assignment/ Seminar
6	Operating safety passive safety: exterior safety	1	
7	Interior safety	1	
8	Deformation behavior of vehicle body,	1	
9	Speed and acceleration characteristics of passenger compartment on impact.	1	
10	Speed and acceleration characteristics of passenger compartment on impact.	1	

S.No.	Topics to be covered	No. of periods	Content delivery method
<b>MT-I ( CO1, CO2)</b>			
	<b>Unit-III</b>	<b>(6)</b>	
11	Airbags, electronic system for activating air bags	1	Lecture/ Lecture with discussion/ Assignment/ Seminar
12	Seat belt, regulations, automatic seat belt tightener system	1	
13	Collapsible & tiltable steering column, bumper design for safety. Collision warning systems, child lock	2	
14	Antilock braking systems	0.5	
15	Electronic stability control system/traction control system.	0.5	
16	Vision enhancement, road recognition system, Anti theft technologies	0.5	
17	Smart card system, number plate coding, central locking system	0.5	
<b>UT-II (CO3)</b>			
	<b>Unit IV</b>	<b>(6)</b>	
18	Active suspension systems, requirement and characteristics,	1	Lecture/ Lecture with discussion/ Assignment
19	Different types, Vehicle Handling and Ride characteristics of f road vehicle, pitch, yaw, bounce control,	1	
20	Power windows, thermal management system, adaptive noise control.	1	
21	Steering and mirror adjustment, central locking system ,	1	
22	Garage door opening system, tyre pressure control system	1	
23	Rain sensor system, environment information system	1	
	<b>Unit V</b>	<b>(6)</b>	
24	Traffic routing system - Automated highway systems	2	Lecture/ Lecture with discussion/ Assignment
25	Lane warning system – Driver Information System, driver assistance systems	2	
26	Data communication within the car, Driver conditioning warning	0.5	
27	Route Guidance and Navigation Systems – vision enhancement system	0.5	
28	In-Vehicle Computing – Vehicle Diagnostics system – Hybrid / Electric and Future Cars – Case studies	1	
<b>MT – II (CO3, CO4, CO5)</b>			
<b>Total</b>		<b>30</b>	

**1. Preamble**

This course imparts knowledge about the sensors and electronic components used in an automobile and the engine control system.

**2. Prerequisite**

1150EC101	Basic Electronics Engineering
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**3. Related Courses**

- IC Engines
- Automotive chassis

**4. Course Educational Objectives**

Students undergoing this course are expected to:

- Gain knowledge about the construction and working of electronic components in an engine management system.
- Gain knowledge about how the combustion and pollution can be varied by sensors.

**5. Course Outcomes**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basic electronic components and controls used in sensors	K2
CO2	Explain the different types of sensors used in an automobile engine	K2
CO3	Describe the ignition and injection methods used in an SI engine	K3
CO4	Describe the fuel injection systems in a diesel engine and the emission control systems	K3
CO5	Explain the electronic systems used in the fuel control system and the dash board unit.	K2

(K2 – Understand; K3 – Apply)

**6. Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	M	L					L		M	L
CO2	H	H	M	L	M	L					L		M	L
CO3	H	H	M	L	M	L					L		M	L
CO4	H	H	M	L	M	L					L		M	L
CO5	H	H	M	L	M	L					L		M	L

H- High; M-Medium; L-Low

**7. Course Content****UNIT I Fundamentals of Automotive Electronics****L-6**

Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

**UNIT II Sensors and Actuators****L-6**

Inductive, Hall Effect, Thermistors, piezo electric, piezoresistive, based sensors. Throttle

position, mass air flow, crank shaft position, cam position, engine speed sensor, exhaust oxygen level (two step, linear lambda and wideband), knock, manifold temperature and pressure sensors. Solenoid, relay (four and five pin), stepper motor

**UNIT III SI Engine Management**

**L-6**

Layout and working of SI engine management systems. Group and sequential injection techniques. MPFI, GDI, Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless (BREAKERLESS) electronic ignition system, Electronic spark timing control

**UNIT IV CI Engine Management**

**L-6**

Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Electronically controlled Unit Injection system. Common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve.

**UNIT V Digital Engine Control System**

**L-6**

Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop and closed loop control – Integrated engine control system, Electromagnetic compatibility – EMI Suppression techniques – Electronic dash board instruments – Onboard diagnosis system.

**Total: 30 periods**

**8. Text Books:**

1. Understanding Automotive Electronics William B Ribbens, SAE 1998
2. Automobile Electronics by Eric Chowanietz SAE

**9. References:**

1. Diesel Engine Management by Robert Bosch, SAE Publications, 3<sup>rd</sup> Edition, 2004
2. Gasoline Engine Management by Robert Bosch, SAE Publications, 2<sup>nd</sup> Edition, 2004

**10. Revised Bloom’s based Assessment Pattern:**

Revised Bloom’s Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2) (Max marks in %)	II (CO3 & CO4) (Max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

### 11. Lecture plan

S.No	Topics to be covered	No. of periods	Content Delivery Method
	<b>Unit –I</b>	<b>(6)</b>	
1	Components for electronic engine management system	0.5	Lecture with discussions/ Seminar/ Assignment
2	Open and closed loop control strategies	0.5	
3	PID control	1	
4	Look up tables	0.5	
5	Introduction to modern control strategies like Fuzzy logic and adaptive control	0.5	
6	Switches, active resistors, Transistors, Current mirrors/amplifiers	1	
7	Voltage and current references, Comparator, Multiplier	1	
8	Amplifier, filters	0.5	
9	A/D and D/A converters.	0.5	
	<b>UT-I (CO1)</b>		
	<b>Unit –II</b>	<b>(6)</b>	
10	Inductive, Hall Effect, Thermistors, piezo electric, piezoresistive, based sensors.	0.5	Lecture with discussions/ Seminar/ Assignment
11	Throttle position sensor	0.5	
12	Mass air flow sensor	1	
13	Crank shaft position, cam position sensor	0.5	
14	Engine speed sensor	0.5	
15	Exhaust oxygen level (two step, linear lambda and wideband) sensor	1	
16	Knock sensor	1	
17	Manifold temperature and pressure sensors.	0.5	
18	Solenoid, relay (four and five pin), stepper motor.	0.5	
	<b>MT-I (CO1, CO2)</b>		
	<b>Unit-III</b>	<b>(6)</b>	
19	Layout and working of SI engine management systems	1	
20	Group and sequential injection techniques	1	

S.No	Topics to be covered	No. of periods	Content Delivery Method
21	Electronic ignition systems and advantages	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
22	Types of solid state ignition systems and their principle of operation	1	
23	Contactless (BREAKERLESS) electronic ignition system	1	
24	Electronic spark timing control.	1	
<b>UT-II (CO3)</b>			
<b>Unit IV</b>		<b>(6)</b>	
25	Fuel injection system parameters affecting combustion, noise and emissions in CI engines.	2	Lecture with discussions/ Seminar/ Case Studies/ Assignment
26	Electronically controlled Unit Injection system	1	
27	Common rail fuel injection system	0.5	
28	Working of components like fuel injector	0.5	
29	Fuel pump, rail pressure limiter, flow limiter	1	
30	EGR valve	1	
<b>Unit V</b>		<b>(6)</b>	
31	Cold start and warm up phases	1	Lecture with discussions/ Seminar/ Lecture with demonstration
32	Idle speed control	0.5	
33	Acceleration and full load enrichment	0.5	
34	Deceleration fuel cutoff	0.5	
35	Fuel control maps	0.5	
36	Open loop and closed loop control	1	
37	Integrated engine control system	0.5	
38	Electromagnetic compatibility – EMI Suppression techniques	0.5	
39	Electronic dash board instruments – Onboard diagnosis system	1	
<b>MT – II (CO3, CO4, CO5)</b>			
<b>Total</b>		<b>30</b>	

**1. Preamble**

This course Engine Testing & Certification imparts knowledge in the area of testing and validation of IC Engines. It enables the learners to expertise themselves in facility engineering, measurements & calibration of equipments used in test cell and analysis of data

**2. Pre-Requisite**

NIL

**3. Links to Other Courses**

Automotive Emission and Control

**4. Course Educational Objectives**

Students undergoing this course are expected to

- Develop in depth knowledge of Engine Testing & Evaluation techniques
- Understand the standards & directives for various types of engine testing
- Develop knowledge on measurements and calibration techniques

**5. Course Outcomes:**

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Illustrate the requirements of Engine Test Cell Facilities	K2
CO2	Generalize the theory of dynamometers & Calibration procedure	K2
CO3	Explain the test standards, full & part throttle performance & maintenance	K2
CO4	Summarize the Engine Emission Measurement for various driving cycles	K2
CO5	Discuss the advanced engine monitoring devices such as combustion photography, swirl measurement and gas exchange process.	K2

**6. Correlation of COs with Programme Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	M	M		L	M		M	L	M	L
CO2	H	H	H	M	M	M		L	M		M	L	M	L
CO3	H	H	H	M	M	M		L	M		M	L	M	L
CO4	H	H	H	M	M	M		L	M		M	L	M	L
CO5	H	H	H	M	M	M		L	M		M	L	M	L

H- High; M-Medium; L-Low

**7. Course Content****Unit 1 Engine Test Facilities**

L-4

Test cell requirements, cell console & control room, ventilation, air conditioning & exhaust, cooling, lubrication/fuel supply systems, noise & vibration control in test cells, electrical systems.

**Unit 2 Engine Dynamometer & Tests Equipments**

L-6

Engine dynamometers, types of dynamometers, dynamometer panels, engine controllers, data acquisition system, fuel consumption meter, air fuel ratio measurement, oil consumption measurement, temperature & pressure measurement, humidity measurement, calibration & maintenance.



**Unit 3 Engine Measurements****L-8**

Engine test standards, full throttle & part throttle performance, road load testing, friction measurement, durability, maintenance.

**Unit 4 Engine Emission Measurements in various modes****L-6**

Emission analyzers, emission cycles for commercial vehicles, tractors & gensets, steady state and transient cycles, dilution tunnel, particulate emissions, calibration and maintenance.

**Unit 5 Advanced Engine Testing****L-6**

Use of special equipments, fuel injection pressure, needle lift, combustion photography, swirl measurement.

**TOTAL: 30 periods****8. Text Books:**

1. A.J.Martyr, M.A.Plint, Engine Testing Theory and Practice, SAE International, Third Edition, 2007.
2. Michael James Plint & Tony Martyr, "Engine Testing - Theory & Practice", 3rd Edition, SAE International, 2007.

**9. References:**

1. HenizHeisler, "Advanced Engine Technology", Vol.1, SAE International 2002
2. Richard D Atkins, "An Introduction to Engine Testing & Development", ISBN 978-0-7680-2099-1, SAE International 2009.

**10. Revised Bloom's based Assessment Pattern:**

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2) (Max marks in %)	II (CO3 & CO4) (Max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

**11. Lecture plan**

S.No	Topics to be covered	No. of periods	Content Delivery Method
	Unit –I	(4)	

S.No	Topics to be covered	No. of periods	Content Delivery Method
1	Test cell requirements, cell console & control room	1	Lecture with discussions/ Seminar/ Assignment
2	Ventilation	1	
3	Air conditioning & exhaust	1	
4	Cooling, lubrication/fuel supply systems	1	
5	Noise & vibration control in test cells	1	
6	Electrical systems	1	
<b>UT-I (CO1)</b>			
<b>Unit –II</b>		<b>(6)</b>	
7	Engine dynamometers, types of dynamometers	0.5	Lecture with discussions/ Seminar/ Assignment
8	Dynamometer panels, Engine controllers	0.5	
9	Data acquisition system	0.5	
10	Fuel consumption meter, air fuel ratio measurement	1	
11	Oil consumption measurement	1	
12	Temperature & pressure measurement	1	
13	Humidity measurement	1	
14	Calibration & maintenance	0.5	
<b>MT-I (CO1, CO2)</b>			
<b>Unit-III</b>		<b>(8)</b>	
15	Engine test standards	1	Lecture with discussions/ Seminar/ Case Studies/ Assignment
16	Full throttle & part throttle performance	2	
17	Road load testing	2	
18	Friction measurement	2	
19	Durability, maintenance	1	
<b>UT-II (CO3)</b>			
<b>Unit - IV</b>		<b>(6)</b>	
20	Emission analyzers	0.5	Lecture with discussions/ Seminar/ Case Studies/ Assignment
21	Emission cycles for commercial vehicles	1	
22	Emission cycles for tractors & gensets	1	
23	Steady state and transient cycles	1	
24	Dilution tunnel	1	
25	Particulate emissions	1	
26	Calibration and maintenance	0.5	
<b>Unit -V</b>		<b>(6)</b>	
27	Use of special equipments	1	Lecture with discussions/ Seminar
28	Fuel injection pressure	1	
29	Needle lift	1	
30	Combustion photography	2	
31	Swirl measurement	1	
<b>MT – II (CO3, CO4, CO5)</b>			
<b>Total</b>		<b>30</b>	