

**M. TECH. DEGREE IN  
AUTOMOTIVE ENGINEERING**

**SYLLABUS  
FOR  
CREDIT BASED  
CURRICULUM**



**DEPARTMENT OF MECHANICAL ENGINEERING  
NATIONAL INSTITUTE OF TECHNOLOGY  
AGARTALA – 799046, INDIA**

**1<sup>st</sup> SEMESTER**

Sl. No.	Subject Code	Name of Subject	Credit
1	<b>PME51C01</b>	Advanced Mathematics	4
2	<b>PME51C02</b>	Automotive Chassis & Transmission	4
3	<b>PME51C03</b>	Advanced Vehicle Dynamics	4
4	<b>PME51C04</b>	Automotive Engine Design	4
5	<b>PME51C05</b>	Computational Fluid Dynamics	4
6	<b>PME51P01</b>	Engine Testing & Pollution Measurements Lab	2
7	<b>PME51P02</b>	FEM Lab	2
8	<b>PME51P03</b>	Seminar	1

### 2<sup>nd</sup> SEMESTER

Sl. No.	Subject Code	Name of Subject	Credit
1.	<b>PME52C06</b>	Automotive Materials & Component Manufacturing	4
2.	<b>PME52C07</b>	Engine Pollution and Control Systems	4
3.	<b>PME52C08</b>	Computational Method In Fluid Flow And Heat Transfer	4
4.	<b>PME52C09</b>	Alternative Fuels & Energy Systems	4
5.	<b>PME52P04</b>	Project Preliminary	4
6.	<b>PME52P05</b>	Automotive Simulation and Analysis Laboratory	2
7.	<b>PME52P06</b>	CFD Laboratory	2
8.	<b>PME52P07</b>	Comprehensive Viva Voice	1

### 3<sup>rd</sup> SEMESTER

Sl. No.	Subject Code	Name of Subject	Credit	Subject Type
1.	<b>PME53P08</b>	Project Work Stage-I	15	Project

### 4<sup>TH</sup> SEMESTER

Sl. No.	Subject Code	Name of Subject	Credit	Subject Type
1.	<b>PME54P09</b>	Project Work Stage-II	20	Project

## **(PME51C01) ADVANCE MATHEMATICS**

## **(PME51C02) AUTOMOTIVE CHASSIS AND TRANSMISSION**

### **Introduction:**

Layout with reference to prime mover location and drive. Frames, Constructional details – Materials – Testing of frames – Integrated body construction- Study of loads, moments and stresses on frame members, computer aided design of frame for passenger and commercial vehicles. Classification of automobile, Types of chassis layout with reference to power plant locations and type of drive, Types of chassis- fully forward, semi forward, Truck or bus chassis, two & three wheeler chassis layout.

### **Steering System:**

Front Axle types. Construction details. Materials. Front wheel geometry viz. Camber, kingpin inclination, caster, toe-in and toe-out. Conditions for true rolling motion of road wheels during steering. Steering geometry. Ackermann and Davis steering. Constructional details of steering linkages. Different types of steering gear boxes. Steering linkage layout for conventional and independent suspensions. Turning radius, wheel wobble and shimmy. Power and power assisted steering – Electric steering – Steer by wire

### **Design of chassis system**

Analysis of loads, moments and stresses at different sections of chassis components due to vibration - Design of propeller shaft, Design of final drive gearing, Design of full floating, semi-floating and three quarter floating rear shafts and rear axle housings.

### **Braking System**

Types of brakes. Principles of shoe brakes. Constructional details, materials. Braking torque developed by leading and trailing shoes. Disc brake theory, constructional details, advantages. Brake actuating system – mechanical, hydraulic, pneumatic. Factors affecting brake performance viz. operating temperature, area of brake lining, brake clearance. Exhaust brakes. Power and power assisted brakes - Antilock braking system , Retarded engine brakes, eddy retarders , Regenerative braking system – Brake by wire- Testing brakes – Road tests, garage tests and tests in the laboratory.

### **Suspension System**

Types of suspension. Factors influencing ride comfort, Suspension springs – leaf spring, shackle and mounting brackets, coil and torsion bar springs. Spring materials, Independent suspension – front and rear. Rubber, pneumatic, hydroelastic suspension – Active suspension system. Shock absorbers Magneto Rheological fluids .Types of wheels. Construction of wheel assembly. Types of tyres and constructional details. Static and rolling properties of pneumatic tyres - computer aided design of leaf springs, coil springs and torsion bar springs.

## **Car Body Details**

Types car bodies – Visibility: regulations, driver's visibility, methods of improving visibility – Safety: Safety Design, constructional details of roof, under floor, bonnet, boot, wings etc.

## **Bus Body Details:**

Types of bus bodies. Floor height, engine location – Entrance and exit location, Constructional details, frame construction, Double skin construction, Types of metal sections used, regulations, Conventional and integral type construction.

**Commercial Vehicle Details: Types of bodies** – Flat platform, drop side, fixed side, tipper body, tanker body.

Construction of commercial vehicle bodies. Dimensions of driver's seat in relation to controls. Drivers cab design.

## **Body Loads and Stress**

Analysis Scalized structure – Structural surface – Shear panel method – Symmetric and Asymmetrical vertical loads in a car – Longitudinal loads – Different loading situations – Load distribution on vehicle structure – Stress analysis of bus body structure under bending and torsion – Stress analysis in integral bus body. Analysis of shock and impulse.

## **AUTOMOTIVE TRANSMISSION**

**Clutches:** Principle, functions, general requirements, torque capacity, types of clutches, cone clutch, single-plate clutch, diaphragm spring clutch, multi-plate clutch, centrifugal clutch, electromagnetic clutch, lining materials, over-running clutch, Clutch control systems.

**Gear Box:** Necessity of gear box, Resistance to motion of vehicle, Requirements of gear box, Functions of gear box, Types, Sliding mesh, Constant mesh, Synchromesh. Principle, construction and working of synchronizing unit, Requirements & applications of helical gears, Gear selector mechanism, Two wheeler gear box, Lubrication of gear box, Overdrive gears, Performance characteristics.

**Drive Lines:** Effect of driving thrust and torque reaction, propeller shaft-universal joints, hooks and constant velocity U.J., Drive line arrangements – Hotchkiss drive & torque tube drive, Rear wheel drive & front wheel drive layouts.

**Final Drive & Rear Axle:** Purpose of final drive & drive ratio, Different types of final drives, need of differential, Constructional details of differential unit, Non-slip differential, Differential lock, Differential housing, Function of rear axle, Construction, Types of loads acting on rear axle, Axle types - semi-floating, full floating, three quarter floating, Axle shafts, Final drive lubrication.

**Transmission with Fluid Flywheel & Torque converter:** Operating principle, Construction

and working of fluid flywheel, Characteristics, Advantages & limitations of fluid coupling, Torque converter, construction and working of torque converter, Performance characteristics, Comparison with conventional gear box.

**Epicyclic Gear Boxes:** Simple epicyclic gear train, Gear ratios, Simple & compound planet epicyclic gearing, Epicyclic gear boxes, Wilson Epicyclic gear train - Construction and operation, Advantages, Clutches and brakes in epicyclic gear train, compensation for wear, performance characteristics.

**Automatic Transmission:** Principle of semi automatic & automatic transmission, Hydramatic transmission, Fully automatic transmission, Semi automatic transmission, Hydraulic control system,

**Continuous variable transmission (CVT)** – operating principle, basic layout and operation, Advantages and disadvantages.

RECOMMENDED BOOKS:

1. Motor Vehicles, Newton, Steed & Garrot, 13th Edition, Butterworths London,
2. Modern Transmission, Judge A. W., Chapman & Hall Std., 1989
3. Automatic Transmission, Chek Chart, A Harper & Raw Publications
4. Steering, Suspension & Tyres, Giles J. G., – Liffle Book Ltd., London
5. Mechanics of Road Vehicles, Steed W., Liffle Book Ltd.
6. Automotive Mechanics K Giri, Khanna Publishers, Delhi, Eighth Edition

*Textbooks:*

1. William F. Milliken, Douglas L. Milliken, Maurice Olley, *Chassis Design*, SAE, 2002.
2. Crouse W.H- “Automotive Chassis and Body”- McGraw-Hill, New York- 1971.
3. Powloski, J., „Vehicle Body Engineering”, Business Books Ltd., 1989.
4. John Fenton, „Vehicle Body Layout and Analysis”, Mechanical Engineering Publication Ltd., London, 1982.
5. *Vehicle Aerodynamics*, SAE, 1996.

**(PME51C03) ADVANCED VEHICLE DYNAMICS**

**MODULE-I**

1. Performance of cars and light trucks: Vehicle drag-deformation of the wheel, deformation of the ground, Total resistance to a moving vehicle- air, rolling and grade resistance, power for propulsion, traction and tractive effort, Road performance curves- acceleration, grad ability and drawbar pull, acceleration time and elasticity, fuel consumption and fuel economy, strategy for lowest fuel consumption, factors affecting fuel economy, CAFÉ, driving schedules – EPA urban and highway cycles, European driving cycles.

2. Road Loads: Air resistance-Mechanics of air flow around a vehicle, pressure distribution on a vehicle, factors affecting rolling resistance, aerodynamic forces – aerodynamic drag, drag components, drag coefficient, aerodynamic aids, aerodynamic side force, lift force, pitching moment, yawing moment, rolling moment, cross wind sensitivity,

**MODULE-II**

3. Vehicle handling: Steering angle, cornering force, low speed turning, high speed cornering, suspension effects on cornering, self-righting torque, slip angle, over steer, under steer, steady state cornering, driving torques on steering, effect of camber, camber thrust, transient effects in cornering,

4. Stability of vehicles: Distribution of weight (Three wheeled and four wheeled vehicles), stability of a vehicle on a slope, Dynamics of vehicle running on a banked track, Stability of a vehicle taking a turn, Braking requirements, stopping distance, braking efficiency, work done in braking, tyre adhesion, braking of vehicles.

5. Road testing methods: Measurement of aerodynamic drag force in a coast – down test, cross wind tests, engine cooling road test, wind noise measurement on the road.

**MODULE III**

6. Suspension: Vehicle dynamics and suspension requirements, choice of suspension spring rate, chassis springs and theory of chassis springs, Gas & hydraulic dampers and choice of damper, damper characteristics, mechanics of an independent suspension system, Roll axis and the

vehicle under the action of side forces.

7. Tyres: Tyre types, relative merits and demerits, tyre dimensions and specifications,

Ride characteristics of tyres, wheel hop, wheel wobble, wheel wander, wheel shimmy, behavior while cornering, cornering force, power consumed by a tyre, effect of driving and braking torque, factors affecting tyre life, tread design.

**References:**

1. W. Steeds- Mechanics of road vehicles- Wildlife book Ltd, London, 1990
2. Thomas D. Gillespie – Fundamentals of road vehicles - SAE, 1992
3. Wolf- Heinrich Hucho – Aerodynamics of road vehicles, SAE
4. J.G. Giles- steering, suspension and tyres, Wildlife books Ltd, London, 1968
5. P.M. Heldt- Automotive chassis, Chilton Co., New York, 1952
6. T.Y. Wong- Theory of ground vehicles, Johnwiley and sons Inc, New York
7. N.K. Giri- Automobile mechanics, Khanna Publishers, Delhi, 1986
8. Kripalsingh- Automobile Engineering-Vol-I, Standard Publishers, Delhi
9. R.P.Sharma- A course in Automobile Engineering, DhanpatRai publications

**(PME51C04) Automotive Engine Design**

**Reference Books**

1. I. C. Engine & Air Pollution – E. F. Obert, Harper & Row Publishers, New York
2. Engine Design – Giles J. G., Liffie Book Ltd.
3. Engine Design – Crouse, Tata McGraw Publication, Delhi
4. I.C. Engine - Maleev V. L., McGraw Hill Book, Co.
5. I. C. Engine – L. C. Litchy, International Student Edition
6. Design of Automotive Engine – A. Kolchin and V. Demidov
7. I. C. Engine – Heywood
8. SAE Handbooks

**(PME51C05) COMPUTATIONAL FLUID DYNAMICS**

**References:**

1. Anderson John D, “Computational Fluid Dynamics”
2. Tannehill, J.e., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Taylor&Francis, 1997.
3. Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers, Engineering Education Systems, 2000.



**(PME51P01)ENGINE TESTING & POLLUTION MEASUREMENTS LAB**

Laboratory work based on the syllabus of the subject Automotive Engine Design.

**(PME51P02) FEM Lab**

**(PME51P03) SEMINAR**

Each student shall prepare a seminar paper on any topic of his/her interest. However, the topic must be somewhat related to the core/elective courses being credited by him/her during the first semester. He/She shall get the paper approved by the faculty advisor and present it in the class in the presence Faculty in charge. Every student shall participate in the seminar. Grade will be awarded on the basis of the quality of the paper, his/her presentation and participation in the seminar.

## **(PME52C07) ENGINE POLLUTION AND CONTROL SYSTEMS**

### **1. POLLUTION - ENGINES AND TURBINES**

Atmospheric pollution from piston engines and gas turbines, global warming.

### **2. POLLUTANT FORMATION**

Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and Smoke  
Particulate emission, effects of pollutions on environment.

### **3. POLLUTION MEASUREMENT**

Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer  
and flame ionization detector, smoke measurement, noise pollution, measurement and  
control.

### **4. CONTROL OF ENGINE POLLUTION**

Engine component, fuel modification, evaporative emission control, EGR, air injection thermal  
reactors, In cylinder control of pollution, catalytic converters, application of microprocessor in  
emission control.

### **5. DRIVING CYCLES AND EMISSION STANDARDS**

Use of driving cycles for emission measurement, chassis dynamometer, CVS system,  
National and International emission standards.

#### ***References:***

- 1. Crouse William, Automotive Emission Control, Gregg Division/McGraw-Hill.*
- 2. Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.*
- 3. George, Springer and Donald J. Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum Press, 1972.*
- 4. Obert, E.F., Internal Combustion Engines and air Pollution, Intext Educational Publishers, 1980.*

## **(PME52C09) ALTERNATIVE FUELS & ENERGY SYSTEMS**

## **(PME52C06) AUTOMOTIVE MATERIALS & COMPONENT MANUFACTURING**

**CLASSIFICATION:** Metals, ceramics, glasses, elastomers, polymers, composites, smart materials, members of each class, nano science materials, material properties viz mechanical, thermal, wear, corrosion / oxidation.

**MATERIAL SELECTION:** Selection strategy, property limits and material indices, function objectives and constraints, performance maximizing criteria

**MATERIAL PROPERTY CHARTS:** Modulus - density, strength – density, modulus – strength, specific stiffness and specific strength, fracture toughness, modulus fracture etc

**SELECTION OF MATERIALS AND SHAPE:** Shape factors, elastic extrusion, elastic body and twisting, failure, bending and twisting, axial loading and column buckling, efficiency of standard sections, material limits for shape factors, microscopic shape and shape factors

**FERROUS ALLOYS:** Types of cast irons, properties, structures, compositions and applications, plain carbon steels, low alloy steels and effects of alloying elements, high alloy steels, stainless steel types, castability, formability, machinability, hardenability and weldability of the material, high temperature steels and super alloys.

**NON FERROUS ALLOYS:** Alloys of copper, aluminium, nickel, magnesium, titanium, lead, tin, zinc - compositions, heat treatments, structures, properties, applications, castability, formability, machinability, hardenability and weldability.

**BODY MATERIALS:** Steels – HSLA, aluminium alloys, magnesium alloys, plastics and ceramics, ULSAB, ULSAS, DP, IF, TRIP Steels

**COMPOSITES:** Types of composites, volume fraction - lamellar composites production and properties of whiskers of silicon carbide, graphite, fibres of zirconia, alumina and boron nitride - metal filaments - boron filaments - glass fibres applications

**NON-METALLIC MATERIALS:** Ceramics, refractories, abrasives, enamels, cement – glasses, polymers: thermosetting and thermoplastics, types of polymerisation, elastomers, electrical conducting polymers. **ELECTRICAL AND MAGNETIC MATERIALS:** P and N type semiconductors, single crystals, soft and hard magnets, superconductors, MEMS materials, nano science materials, smart materials, shape memory alloys.

### **COMPONENT MANUFACTURING**

**ENGINE COMPONENTS:** Casting of engine block - conventional and expendable pattern, machining of engine blocks in machining center. Preparation of casting for cylinder heads, forging of crank shaft, connecting rod and gudgeon pins, machining and heat treatment, casting of piston by gravity casting, squeeze casting, machining and finishing, upset forging of valves, heat treatment and surface improvement, cylinder liners and piston ring manufacturing. Engine bearing manufacturing.

**TRANSMISSION COMPONENTS:** Manufacturing of friction plates using conventional blanking and fine blanking. Manufacture of composite friction lining, composite moulding of phenol formaldehyde lining. Casting of gear box casing, precision forging of gears, gear hobbing, shaping, powder metallurgy, orbital forming of spur, helical, and bevel gears, hypoid gears, heat treatment and finishing. Continuous casting of propeller shaft, extrusion of propeller shaft, extrusion dies, heat treatment and surface hardening of propeller shaft, composite propeller shaft manufacturing. Forging of rear axles, casting of rear axle casing, wheels, brake drum, tyre manufacturing.

**BODY COMPONENTS:** Introduction, thermoforming and hydro forming, press forming, welding of body panels, resistance welding and other welding processes. Introduction, principle of injection moulding, injection moulding of instrument panel, moulding of bumpers, reinforced reaction injection moulding, tooling and tooling requirements, manufacture of metal/polymer/metal panels. Adhesives and sealants, leaf spring manufacturing, composite leaf springs, wrap forming of coil springs.

**SURFACE COATINGS:** Chemical vapour deposition, physical vapour deposition, sol-gel processing, spraying, plating, painting in paint booth.

#### **REFERENCES:**

- Michael F. Ashby, "Materials Selection in Mechanical Design", Butterworth Heinemann, 2005.
- Daniel Yesudian C., "Materials Science and Metallurgy", Scitech Publications (India), 2004.
- Polmear I.J., "Light Alloys", Arnold Publishers, 1995.
- Swarup D. and Saxena M.N., "Elements of Metallurgy", Rastogi Publishers, Meerut, 1994.
- Srinivasan N.K. and Ramakrishnan S.S., "The Science of Engineering Materials", Oxford and IBH Pub. Co., New Delhi ,  
□ 1993.
- Van Vlack L.H., "Elements of Materials Science and Engineering", Addison Wesley, New York, 1991.
- Guy A.G., "Elements of Physical Metallurgy", Oxford & IBH Pub. Co., 1990.
  
- Philip F. Ostwald & Jairo Munuz, "Manufacturing Processes and Systems", John Wiley & Sons, New York, 1998.
- Degarmo E.P., "Materials and process in Manufacturing", Macmillan Publishing Co., 1997.
- Heldt P.M., "High Speed Combustion Engines", Oxford IBH publishing Co., Calcutta, 1996.
- Kalpakjian, "Manufacturing and Engineering and Technology", Addison Wesley, Publishing Company, 1995.
- Sanjay K Mazumdar, "Composites Manufacturing", CRC Press, NY, 2003.

**(PME52P04) PROJECT PRELIMINARIES**

Preliminary work about project will be carried out.

**(PME52P05)AUTOMOTIVE SIMULATION AND ANALYSIS LABORATORY**

**(PME52P06) CFD LABORATORY**

Laboratory work based on the subject **PME52C07**

**(PME52P07) COMPREHENSIVE VIVE VOCE**

Each student is required to appear for the Comprehensive Viva-voce Examination. This is an oral examination based on the courses (Theory, laboratory and seminars) undergone by the students during the first and second semester M.Tech Programme.