Shivaji University, Kolhapur

Structure of Final Year Engineering (Revised)

(To be implemented from Academic year 2016-17)

Automobile Engineering

Scheme of Teaching and Examination

Semester-VII

Sr.No.	Subject	Teaching Scheme (Hrs.)				Examination Scheme(Marks)				
		L	T	P	Total	Theory	T/W	OE	POE	Total
01	I.C. Engine Design	3	---	2	5	100	25	---	---	125
02	Vehicle Dynamics	3	---	2	5	100	25	---	---	125
03	Finite Element Analysis	3	---	2	5	100	25	25	---	150
04	Vehicle Maintenance	3	---	2	5	100	25	---	---	125
05	Elective-I	3	---	--	3	100	--	--	---	100
06	I.C.Engine Testing Lab	---	---	2	2	---	25	---	25	50
07	Automotive Industrial Training	--	---	---	---	---	25*	---	---	25
08	Project Phase-I	---	---	2	2	---	50	50	---	100
	Total	15	---	12	27	500	200	75	25	800

*** Assessment of Automotive Industrial Training will be carried out with Project Phase-I**

Semester-VIII

Sr.No.	Subject	Teaching Scheme (Hrs.)				Examination Scheme(Marks)				
		L	T	P	Total	Theory	T/W	OE	POE	Total
01	Alternative Fuels and Emission	3	---	2	5	100	25	---	---	125
02	Automotive Electronics	3	---	2	5	100	25	---	---	125
03	Automotive System Design	3	---	2	5	100	25	25	---	150
04	Vehicle Performance and Testing	3	---	2	5	100	25	25	---	150
05	Elective-II	3	---	--	3	100	---	---	---	100
06	Project Phase-II	---	---	4	4	---	75	75	---	150
	Total	15	---	12	27	500	175	125	--	800

Elective –I

1. Advanced Engine Technology
2. Computational Fluid Dynamics
3. Tribology
4. Optimizations Methods in Engineering Design
5. Transport Management

Elective-II

1. Automotive Noise, Vibration and Harshness (NVH)
2. Automotive Aerodynamics
3. Fuels, Combustion and Emission Control
4. Automotive Control Systems
5. Energy Engineering

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B.E. (Automobile) Semester VII (Revised)

1. I. C. ENGINE DESIGN

Teaching Scheme:
Lectures: 3 hrs/week
Practical: 2 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)
Term Work: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Design of Engine component.
- Design of bearing for Engine.
- Design the standard components against fluctuating loads.
- Identify the techniques of providing the optimum efficiency to be applied on individual engine component.

Course Content:

1. Design for Fluctuating Loads: 6

Fluctuating stresses, S-N diagram for fatigue loading, Endurance limit, Endurance strength modifying factors, Stress concentration-causes and remedies, Notch sensitivity, Design for finite and infinite life under reverse stresses, Cumulative damage in fatigue failures, Soderberg and Goodman diagrams, Modified Goodman diagram. Variables stresses, reversed, repeated, fluctuating stresses, Fatigue Failure, Static and fatigue stress concentration factors.

2. Engine Functional Design: 6

Selection of engine type, Stroke & Bore, No. of cylinders, cylinder arrangement, Design of Cylinder liner, cylinder head, Design considerations for Combustion chamber, engine balancing, Selection of firing order.

3. Engine Component Design: 6

Design of Piston, Piston pin, Connecting Rod, Crankshaft

4. Design of valve gear train: 6

Design of Valve, rocker arm, Push rod, cam shaft, cam and follower, Flywheel.

Design of cooling & lubrication system:

Selection of cooling system, Design of radiator, water pump, selection of lubricating oil and pump

5. Sliding Contact Bearings: 6

Bearing materials and their properties, Bearing types and constructional details, Hydrodynamic theory of lubrication, Raimondi and Boyd method, Design of bearings, bearing performance parameters.

6. Rolling Contact Bearing: 6

Types of rolling contact bearings, static and dynamic load, Stribeck's Equation, Equivalent bearing load, load life relationship, capacities, Bearing life, Load factor, Selection of bearings from manufacturers catalogue, Lubrication and mountings, dismounting and preloading of bearings.

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Termwork:

1) Assembly & Detail drawing of existing engine by actual measurements
2) Demonstration on stress concentration by photo elasticity
3) Experiment on Journal bearing
4) Design of engine components
5) Detail drawing of components sheet of A1 size
6) Engine assembly drawing sheet of A1 size
7) Assignment on Rolling contact bearing
8) Assignment on Sliding contact bearing
9) Assignment on finite Element analysis of any one engine component.

Books Recommended:

1. S. P. Patil, Mechanical System Design, Jaico Publications,
2. V. L. Maleev, I. C. Engine, McGraw-Hill Book Co. Ltd., New Delhi, Second Edition
3. Gill P. W., Smith J. H., Zurich E. J., Fundamentals of I. C. Engine, Oxford & IBH Pub. Co., New Delhi.
4. E. F. Obert, I.C. Engine & Air Pollution , Harper & Row Publishers, New York
5. Heywood J.B.,I. C. Engine Fundamentals, Mc Graw Hill Book Co., New Delhi
6. Litchy, I. C. Engine, McGraw Hill
7. Bhandari V. B., Design of Machine Elements, Second Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi
8. Joseph E. Shigley & Larry D. Mitchell, Mechanical Engineering Design, Sixth Edition, McGraw-Hill International Book Company
9. M.F. Spotts & T.E. Shoup, Design of Machine Elements, Seventh Edition, Pearson Education
10. George E. Dieter, Engineering Design- A Material and Processing Approach, Second Edition, McGraw-Hill International Edition
11. Robert C. Junivall, Fundamentals of Machine Component Design, John Wiley & Sons
12. Paul H. Black & O. Eugene Adams Jr., 'Machine Design', Third Edition, McGraw-Hill International Edition
13. P. Kannaih, Machine Design, Scitech Publications (I) Pvt. Ltd., Second Edition
14. A.Kolchin and V.Demidov, Design of Automotive Engines, Mir Publishers, Moscow, 1984.
15. Colin R. Forguson and Kirkpatrick, Internal Combustion Engines, Applied Thermodynamics, 2nd Edition, Wiley India.

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2. VEHICLE DYNAMICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week	Theory Paper: 100 marks (3 hrs. duration)
Practical: 2 hrs/week	Term Work: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Explain the importance of Vehicle Dynamics
- Identify the effect of different parameters on Performance Characteristics of Road Vehicles.
- Summarize braking characteristics.
- Identify different handling conditions of vehicles.
- Classify and compare different vehicle ride models.

1. **Introduction** **6**

   Introduction to vehicle dynamics, Fundamental approach to modeling- lumped mass, coordinate systems, Newton's second law, Dynamic axle loads, Power limited acceleration- engines, power train, selection of gear ratio, Traction limited acceleration- transverse weight shift due to drive torque

2. **Performance Characteristics of Road Vehicles** **6**

   Power for propulsion, Traction and Tractive effort, Road performance curves: Acceleration, Gradability & Drawbar Pull, Determination of CG, Weight distribution, Stability of vehicle on slope, Dynamics of vehicles on Banked tracks, Stability of vehicle taking a turn, Gyroscopic Effects

3. **Braking Characteristics** **6**

   Basic Equations (Constant Deceleration, deceleration with wind resistance), Energy / Power absorbed during braking, Braking Forces, Brake factor, Mechanism of tire-road friction, Federal Requirements for Braking Performance, Brake proportioning, Braking efficiency, Rear wheel lockup, Braking of vehicle - Braking applied to rear wheels, Front wheels and all four wheels, Braking of vehicle moving in a curved path, Calculation of mean lining pressure & heat generation during braking

4. **Handling Characteristics** **7**

   Steady State Handling: Low speed turning, Off tracking, High speed cornering, Neutral steer, Under steer and over steer, Steady state response, Yaw velocity, Lateral Acceleration, Curvature response, jack-knifing in articulated vehicle.
   Suspension effects on Cornering- Rolling moment distribution, Camber Change, Roll steer, Lateral Force compliance steer, Aligning Torque, Effect of tractive force on Cornering.
   Vehicle Test for handling performance: Steady state testing, constant speed test, constant steer angle test, constant radius test.
   Transient Handling: Basic principles, differential equations of motions.
   Directional Stability

5. **Ride Characteristics** **7**

   Excitation sources, Vehicle response properties – suspension isolation, suspension stiffness, suspension damping, wheel hop resonance, Suspension nonlinearities, Rigid body bounce/pitch motions, bounce/pitch frequencies, Tolerance to seat vibrations, Human

response to vibrations, vehicle ride models- Two degree freedom model for sprung & unsprung mass, Two degree freedom model for pitch & bounce, roll centre & roll axis. Introduction to random vibrations

6. **Recent trends in vehicle dynamics** **4**
   Stability Control systems, Introduction of vehicle sensors, Central tire inflation systems, Influence of parameters at vehicle rollover, Vehicle dynamics simulations

Termwork: (Any Ten)

1) Acceleration performance problems
2) Vehicle performance problems-I
3) Vehicle performance problems-II
4) Braking problems
5) Handling Characteristics problems
6) Ride Characteristics problems
7) Active roll control
8) Traction control
9) Electronic stability control
10) Adaptive cruise control
11) Semi-active suspension
12) Anti-squat/anti-dive geometries

References:

1. R. Venchatachalam, *Mechanical Vi*brations, PHI Publication, 1st Edition 2014.
2. Thomas D. Gillespie, *Fundamentals of Vehicle Dynamics*, Society of Automotive Engineers, 2012.
3. J.G. Giles, *Steering, Suspension and Tyres*, Illiffe Books Ltd, 1968
4. J. Y. Wong, *Theory of Ground Vehicles*, John Wiley and Sons Inc., New York, 2001
5. Hans Pacejka, *Tyre and Vehicle Dynamics*, SAE Publications, 2nd edition, 2011.
6. Blundell, M. and Harty, D., *The Multi body Systems Approach to Vehicle Dynamics*, Elsevier Publications, 2011.

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3. FINITE ELEMENT ANALYSIS

Teaching Scheme:
Lectures: 3 hrs/week
Practical: 2 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)
Term Work: 25 marks
Oral: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Discretize the physical domain using appropriate elements and check the quality of mesh.
- Apply variational approach for analysis of structural problems using.
- Apply weighted Residual method for heat transfer analysis.
- Analyze the dynamic behavior of structure using FEM.
- Use isoparametric formulation for irregular geometries.
- Apply thumb rules for result interpretation and check the validity of finite element model.

1. Introduction 6

Steps of finite element analysis, Basic idea of FEM – direct stiffness method,
Discretization-element types, selection of elements, no of elements, node numbering scheme, element quality checks.
Interpolation models- Compatibility and completeness requirement. Linear and higher order elements, selection of interpolation polynomial, global natural and local coordinate system. Axisymmetric elements.

2. Structural analysis 6

Variational formulation, one dimensional and two dimensional structural analysis. Assembly and solution of finite element equations. Analysis of truss structure. Axisymmetric structural analysis.

3. Formulation of element characteristics matrix for vector problems 6

Weighted residual methods. General finite element formulation of vector problems, one dimensional two dimensional heat transfer analysis, axisymmetric thermal analysis.

4. Dynamic analysis 6

Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, Lumped mass matrix, Evaluation of Eigen values and Eigen vectors.

5. Higher order and isoparametric elements. 6

One and two dimensional higher order elements, isoparametric elements, evaluation of finite element equation for higher order elements, numerical integration, Lagranges interpolation polynomial, Harmite interpolation polynomial, structural beam, plate and shell elements.

6. Result interpretation and verification of results 6

Sources of errors in FEA solution, model validity and accuracy, mesh refinement, thumb rules for viewing results. Computer implementation of finite element analysis program-preprocessing, solution processing and post processing.

Termwork: (Analysis of following any Ten problems using any analysis software)

1. Rod element subjected to tension & comparison with analytical answer
2. Cantilever Beam element exercise and comparison with analytical answer
3. Plane Stress analysis of Bracket/ Plate
4. Static structural analysis of Allen Wrench
5. Demonstration of thermal analysis
6. Steady state thermal analysis cylinder
7. Thermal analysis of composite wall
8. Thermal analysis of turbine blade
9. Linear buckling analysis of column.
10. Dynamic analysis of dropping an aluminum container on a steel table top.
11. Harmonic analysis of spring mass system.
12. Contact analysis of pinhole with pin
13. Non linear analysis of plate subjected cyclic load.
14. Transient thermal analysis of a casting process.

References:

1. O. C. Zienkewitz and Taylor, *The Finite Element Method*, Vol. I and II, McGraw Hill, 2013
2. J. N. Reddy, *An Introduction to Finite Element Method*, McGraw Hill, 2013.
3. S. S. Rao, *The Finite Element Method in Engineering*, Pergamon press, 2013
4. M. J. Fagan., *The Finite Element Analysis: Theory And Practice*, Longman Scintific and Technology, 1992.
5. R. D. Cook, Davis S. Malkus, Michael E. Plesha and Robert J. Witt, *Concepts and Applications of Finite Element Analysis*, 4th Edition, Wiley Student Edition, Wiley. 2015.
6. Huebner, K. H., and E. A. Thornton. *The Finite Element Method for Engineers,* 2nd ed. New York: John Wiley and Sons, 1982
7. Baker, A. J. *Finite Element Computational Fluid Mechanics.* New York: McGraw- Hill,
8. Desai and Abel, *Introduction to the Finite Element Method*, CBS Publishers & Distributors, 1972.
9. K.L. Bathe and E.L. Wilson, *Finite Element Methods*, Prentice Hall, 1976.
10. C.S. Krishnamoorthy, *Finite Element Analysis, Theory and Programming*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1987.
11. T.R. Chandrapatla and A.D. Belegundu, *Introduction to Finite Elements in Engineering*, Prentice Hall, 1991.

12 David V Hutton *Fundamentals of Finite element analysis* Tata McGraw Hill

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4. VEHICLE MAINTENANCE

Teaching Scheme:
Lectures: 3 hrs/week
Practical: 2 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)
Term Work: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Differentiate the various forms and records of work shop.
- Determine the functioning of engines and its trouble shooting.
- Identify the Chassis and suspension maintenance.
- Use the Electrical equipments and trouble shooting.
- Summarize the trouble shoots in fuel block, Radiator boiling and lubrication system.

1.	**Maintenance of Records and Schedules** Importance of maintenance, preventive (scheduled) and breakdown (unscheduled) maintenance, requirements of maintenance, preparation of check lists. Inspection schedule, maintenance of records, log sheets and other forms, safety precautions in maintenance.	6
2.	**Engine Maintenance–Repair and Overhauling** Dismantling of engine components and cleaning, cleaning methods, visual and dimensional inspections, minor and major reconditioning of various components, reconditioning methods, engine assembly, special tools used for maintenance overhauling, engine tune up.	6
3.	**Chassis Maintenance-Repair and Overhauling** Mechanical and automobile clutch and gear box, servicing and maintenance, maintenance servicing of propeller shaft and differential system. Maintenance servicing of suspension systems. Brake systems, types and servicing techniques. Steering systems, overhauling and maintenance. Wheel alignment, computerized alignment and wheel balancing.	6
4.	**Electrical System Maintenance-Servicing and Repairs** Testing methods for checking electrical components, checking battery, starter motor, charging systems, DC generator and alternator, ignitions system, lighting systems. Fault diagnosis and maintenance of modern electronic controls, checking and servicing of dash board instruments.	6
5.	**Maintenance of Fuel System, Cooling Systems, Lubrication System and Vehicle Body** servicing and maintenance of fuel system of different types of vehicles, calibration and tuning of engine for optimum fuel supply. Cooling systems, water pump, radiator, thermostat, anticorrosion and antifreeze additives. Lubrication maintenance, lubricating oil changing, greasing of parts. Vehicle body maintenance, minor and major repairs. Door locks and window glass actuating system maintenance.	6
6.	**Restraint Systems: Theory, Diagnosis, and Service** Seat Belts , Seat Belt Service, Air Bags, Electrical System Components Diagnosis, Servicing the Air Bag System, Other Protection Systems	6

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Termwork:

1. Clutch overhaul of light / heavy duty vehicle
2. Clutch overhaul of two or three wheeler vehicle
3. Final drive & differential overhaul
4. Rear axle hub greasing
5. Dismantling & assembly of sliding mesh gearbox
6. Engine dismantling and assembly
7. Engine top overhaul
8. Wear measurement of engine components
9. Cooling system overhaul
10. Lubrication system overhaul
11. Hydraulic brake system overhaul
12. Demonstration and overhaul of Front axle of light/heavy duty vehicle

REFERENCES:

1.John Doke"FleetManagement",McGraw-HillCo.1984.
2.James D Halderman - Advanced Engine Performance Diagnosis – PHI - 1998.
3. Service Manuals from Different Vehicle Manufacturers.

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5. ELECTIVE-I ADVANCED ENGINE TECHNOLOGY

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Classify the engines with respect to various aspects.
- Design the various engine parts.
- Understand the different engine systems.
- Explain the advanced engine technology in two wheeler engines.
- Use optimization techniques in engine design.

1. Engine basic Theory **6**

Engine types and their operation-classification-operating cycles of S.I. and C.I. engines-Engine design and operating parameters-mean effective pressure-volumetric efficiency-typical design and operating data for I.C. engines. Two and four stroke engines-typical performance curves foe automotive engines-performance maps, performance-testing of engines-turbo vehicles-jet engine propulsion.

2. Design of Engine Components **6**

Materials, construction and design aspects-design of piston assembly-Design and drafting of connecting rod, cylinder block, flywheel, ports, valves, cam shaft drives and valve actuating mechanism using CAD.

3. Advanced Fuel Supply, Ignition, Cooling and Lubricating Systems **6**

Injectors-Design aspects-Conventional and Electronic ignition systems for S.I. engines, radiator design aspects, DTSi system, Engine management system, four valve system, HET in Honda activa, Five fuel saving technologies, distributor less ignition system, waste spark technology, MPFI and CRDI in detail, VTEC-Honda technology, APDV technology in Honda two wheelers.

4. Air Motion Combustion and Combustion Chambers **6**

Swirl and turbulence-Swirl generation-Combustion in S.I. engines-Flame travel and detonation-Variable affecting knock-Combustion chambers of S.I. engines-Combustion process in C.I. engines-Ignition delay-Factors affecting delay-Knock in C.I. engines-Cylinder pressure data and heat release analysis.

5. Scavenging, Supercharging and New Engine Technology **6**

Importance and types of scavenging-Effect and limitations of supercharges in S.I. engines-Mechanical superchargers and turbocharging-Stratified charge and Lean Burn engines-Different approaches to lean burn-Low heat rejection engines-Surface ignition concept-Electronic fuel supply system-Electronic engine Management.

6. Optimization techniques in engine design **6**

Different Optimization techniques, optimization of air intake system, optimization of exhaust system, NVH analysis

References:

1. J.B.Heywood, *Internal Combustion Engine Fundamentals*, **McGraw Hill Book Co**., 2013
2. Richard Stone, *Introduction of Internal Combustion Engines*, **McMillan**, London, 2010.
3. M. Khovakh, *Motor Vehicle Engines*, **Mir Publishers**, Moscow, 1977.
4. Robert Bosch, *Automotive Hand Book*, **SAE**, 2011.
5. A. Ravindran, K.M. Ragsdell and G. V. REKLAITIS, , Engineering Optimization, Methods and Applications, 2ND Edition, Wiley Student Edition, Wiley.

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5. ELECTIVE-I COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Describe the physical significance of the governing equations for fluid dynamics and heat transfer.
- Develop finite difference implicit & explicit algorithms for fluid flow and heat transfer problems.
- Analyze the errors & stability in CFD discetization schemes.
- Develop finite volume algorithms for fluid dynamics & heat transfer problems.
- Select appropriate grid generation methods for CFD analysis.
- Apply different CFD Techniques to various fluid flow problems.

1. Equations of fluid dynamics. **6**

Introduction of CFD.- CFD as design and research tool, Models of fluid flow, substantial derivative, divergence of velocity, conservative and noncoservative forms of continuity, momentum (Navier Stokes equation) and energy equations. Integral and differential analysis, physical boundary conditions.

2. Finite difference formulation. **6**

Mathematical behavior of partial differential equations, Elliptic hyperbolic and parabolic equations. Finite difference approximation, difference equations. Implicit and explicit approximation, Crank Nicolson method. Error and stability analysis.

3. Finite volume method. **6**

FVM. For Steady state diffusion, convection diffusion problems, tridigonal matrix algorithm. Implementation of boundary conditions. Finite volume method for two-dimensional diffusion problems, Properties of discretization schemes, FVM for unsteady flows.

4. Grid transformation: **6**

Need of transformation, General transformation equation, non dimensionalization of equations of fluid motion, metrics and Jacobian. Forms of governing equations particularly suited for CFD. Stretched grids, boundary fitted coordinate system. Elliptic and adaptive grids. Unstructured mesh for finite volume method.

5. CFD techniques **6**

Lax Wandroff technique, MacMacormac's technique-viscous flows, conservation form and space marching solution, Relaxation techniques with inviscid flow, over relaxation

and under relaxation. Alternating direction implicit technique, pressure correction technique. Incompressible N-S equation. Staggered grid. Simple algorithm, computer grapjics technique. Solution of unsteady N-S equation, higher order upwind differencing examples.

6. Applications of CFD. **6**

Subsonic supersonic isentropic nozzle flow, purely subsonic isentropic nozzle flow. Fluid flow problems in IC engines- flow through manifolds, air motion in cylinder, turbulence modeling and characterization of turbulence mixing.

References:

1. J. D. Anderson, Computational Fluid Dynamics: The Basics with Applications, McGraw Hill.
2. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer_, Second Edition, Narosa Publishing House.
3. K. A. Ho_mann, S. T. Chiang, Computational Fluid Dynamics for Engineers - Volume 1_, Engineering Education System.
4. O. Zikanov, Essential Computational Fluid Dynamics, Wiley India.
5. J. Tu, G. H. Yeoh and C. Liu, Computational Fluid Dynamics: A Practical Approach, Butterworth Heinemann (Indian Edition)
6. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis
7. H. K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson Education (Indian Edition).
8. A. W. Date, Introduction to Computational Fluid Dynamics, Cambridge

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5. ELECTIVE-I TRIBOLOGY

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Describe the theories of friction and wear mechanisms.
- Apply principle of hydrodynamic lubrication for designing bearing.
- Analyze and optimize the hydrostatic bearing for minimum energy loss.
- Apply Reynolds equation for designing gas lubrication system.
- Select appropriate surface treatment for minimum wear and high corrosion resistance.

1. **Introduction:** History of tribology, tribology in design, industrial applications of tribology, economic aspects of tribology, tribological aspects for engine componenats such as bearings, reciprocating components, valve train. Methods of solution of tribological problems. **6**

2. **Friction and wear**: Laws of friction, causes of friction, friction measurement, theories of friction-Adhesion, abrasive, Amonto's theory, Tomlion's and Hardy theory of molecular attraction. **6**

   Introduction to wear- types of wear and wear mechanisms, factors affecting on wear, measurement of wear. Theories of wear. Methods of controlling wear.

3. **Hydrodynamic Lubrication**:-Principle, mechanism of pressure development in oil film, Reynolds equation for hydrodynamic lubrication, hydrodynamic journal bearing, analysis of hydrodynamic journal bearing, Sommerfield number, design consideration in hydrodynamic bearing. **6**

4. **Hydrostatic lubrication**: Principle, advantages, limitations and applications of hydrostatic lubrication, hydrostatic step bearing analysis. Energy loss in hydrostatic bearing. Optimum design of hydrostatic bearing, hydrostatic conical bearing. Rheodynamic lubrication. **6**

5. **Elastohydrodynamic lubrication and Gas lubrication**: Elastohydrodynamic lubrication between two contacting bodies. Hertz's equation for deformation and pressure. Applications of elastohydrodynamic lubrications. **6**
   Gas lubrication-requirments, merits and demerits of gas lubrication, Reynolds equation for gas lubrication, Air bearings.

6. **Surface engineering**: Introduction, concept and scope of surface engineering, manufacturing of surface layers. Surface engineering for wear and corrosion resistance-diffusion and coating. Properties of coatings. Selection of coating for wear and corrosion resistance. **6**

References:

1. Bowden, F.P. & Tabor, D., Friction and lubrication of solids, Oxford University press. 1986.
2. Ernest Rabinowiez, Friction and wear of materials, Interscience Publishers, 1995
3. Neale, M.J. Tribology-Hand Book, Butterworth, 1995
4. Fuller D. D., Theory and practice of lubrication of engineers, John Wiley sons, 1984
5. Gross, W. A., Gas film lubrication, Willey, 1980.

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5. ELECTIVE-I OPTIMIZATION METHODS IN ENGINEERING DESIGN

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Explain basic theoretical principles in optimization
- Apply optimization techniques
- Solve different engineering problems
- Use appropriate methods to solve particular problem

1.	**Introduction to Optimization**: Engineering applications of optimization, statement of optimization problem, classification of optimization problem. **Classical Optimization Techniques**: Introduction, single variable optimization, multi variable optimization with no constraint, equality constraint, in equality constraint, convex programming problems	6
2.	**Linear programming**: Applications of Linear Programming, Standard form of linear programming, geometry of linear programming, solutions of system of linear simultaneous equations, pivotal reduction of general system of reduction, simplex algorithms, Two Phases of the Simplex Method, Duality in Linear Programming, Decomposition Principle, Sensitivity or Post optimality Analysis, Transportation Problem, Karmarkar's Method, Quadratic Programming.	6
3.	**Non-linear programming - One dimensional Minimization methods:** elimination methods, unrestricted search, exhaustive search, half interval method, golden section method, Interpolation methods - Quadratic Interpolation Method, Cubic Interpolation Method Newton method, Quasi Newton method, secant method, Practical Considerations	6
4.	**Non-linear programming - Unconstrained optimization techniques:** Direct search method, random search method, grid search method, Powell's method, Simplex method. Indirect Search method, gradient of functions, descant method, conjugate gradient method, Newton's method, Quasi Newton method	6
5.	**Non-linear programming - Constrained Optimization:** Direct methods - random search method, complex method, sequential linear programming, sequential quadratic programming and generalized reduced gradient method, Indirect method- Transformation Techniques, Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Exterior Penalty Function Method, Convex Programming Problem,	6
6.	Extrapolation Technique in the Interior Penalty Function Method, Extended Interior Penalty Function Methods, Penalty Function Method for Parametric Constraints, Augmented Lagrange Multiplier Method	6

Reference Books:

1. S.S. Rao, Engineering Optimization – Theory & practice, New Age International Publication.
2. Kalyanmoy Deb, Optimization for Engineering Design, Prentice Hall of India.
3. Besequndle A.D., Optimization concepts and application in engineering, Pearson.
4. Ashok D. Belegundu, Tirupathi R. Chandrupatla, Optimization Concepts and Applications in Engineering, Prentice Hall of India.
5. R. Fletcher, Practical Methods of optimization, John Wiley.
6. Principles of Optimisation Design- Modeling and Computation**,** Panos Y. Papalambros, Douglass J. Wilde.
7. A. Ravindran, K.M. Ragsdell and G. V. REKLAITIS, Engineering Optimization Methods and Applications, 2ND Edition, Wiley Student Edition, Wiley.

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5. ELECTIVE-I TRANSPORT MANAGEMENT

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- State motor vehicle acts
- Explain the taxation methods.
- Express the importance of insurance.
- Illustrate passenger and goods transport system.

1. Motor Vehicle Act 6

Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Accidents, Causes & analysis, Liabilities & preventive measures, Rules & regulations, Responsibility of driver, Public & public authorities, Offences, penalties & procedures, Different types of forms, Government administration structure, Personnel, Authorities & duties, Rules regarding construction of motor vehicles.

2. Taxation 6

Objectives, Structure & methods of laving taxation, Onetime tax, Tax exemption & tax renewal

3. Insurance 6

Insurance types & significance, Comprehensive, Third party insurance, Furnishing of particulars of vehicles involved in accident, MACT (Motor Accident Claims Tribunal), Solatium Fund, Hit & Run case, Duty of driver in case of accident, Surveyor & Loss Assessor, Surveyors report

4. Passenger Transport Operation 6

Structure of passenger transport organizations, Typical depot layouts, Requirements and Problems on fleet management, Fleet maintenance, Planning - Scheduling operation & control, Personal & training-training for drivers & conductors, Public relations, Propaganda, publicity and passenger amenities, Parcel traffic., Theory of fares-Basic principles of fare charging, Differential rates for different types of services, Depreciation & debt charges, Operation cost and Revenues, Economics & records

5. Goods Transport Operation 6

Structure of goods transport organizations, Scheduling of goods transport, Management Information System (MIS) in passenger / goods transport operation, Storage & transportation of petroleum products

6. Advance Techniques in Traffic Management 6

Traffic navigation, Global positioning system

References Books

1. Motor Vehicle Act - Govt. of India Publications.
2. S.K. Shrivastava, "Economics of Transport"
3. "Transport Development in India", S. Chand & Co. Pvt. Ltd., New Delhi.
4. Santosh Sharma, "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi.
5. P.G.Patankar, "Road Passenger Transport in India", CIRT, Pune.

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6. I. C. ENGINE TESTING LAB

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term Work: 25 marks
Practical and oral: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Explain ISI codes for engine testing
- Conduct different tests on IC engine
- Analyze test data for finding various parameters of I.C Engines
- Explain heat balance sheet

List of experimrents: (Minimum Ten):

1. Introduction to ISI codes for engine testing
2. Trial on multi-cylinder petrol engine – Morse test
3. Trial on multi-cylinder petrol engine – Variable speed test
4. Trial on single cylinder diesel engine – heat balance sheet
5. Trial on single cylinder petrol engine - Variable speed test
6. Trial on computerized single cylinder diesel engine
7. Trial on computerized multi-cylinder diesel engine
8. Measurement of air/fuel ratio of diesel engine
9. Measurement of air/fuel ratio of petrol engine
10. Trial on single cylinder petrol engine – constant speed test
11. Trial on single cylinder diesel engine (Friction power)
12. Trial on Multicylinder engine (LPG)
13. Industrial visit to any engine testing industry.

References:

1. V. Ganeshan, I.C. Engine, 3rd Edition, Tata McGraw Hill
2. V. L.Maleev, I. C. Engine, McGraw Hill Book Co. Ltd., New Delhi, Second Edition
3. Gill P. W., Smith J. H., Zurich E. J.Fundamentals of I. C. Engine, Oxford & IBH Pub. Co., New Delhi.
4. E. F. Obert,I.C. Engine & Air Pollution –Harper & Row Publishers, New York
5. Mathur & Sharma, I. C. Engine, Dhanpat Rai & Sons, New Delhi
6. Heywood J.B., I. C. Engine Fundamentals, Mc Graw Hill Book Co., New Delhi
7. Litchy, I. C. Engine

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7. AUTOMOTIVE INDUSTRIAL TRAINING

Teaching Scheme:

Examination Scheme:
Term Work: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Express the techniques observed during training
- Explain applications of advanced tools & techniques
- Describe daily routines, rules followed during working in industry

The student has to undergo Automotive Industrial Training of minimum Two Weeks in summer vacation, after T.E. (Automobile) - II, in an automotive / auto component manufacturing industry. Each student has to prepare a report on industrial training of about 25 pages of "A4" size sheets in single bound copy.

An assessment of his training will be done based on the quality of the work & preparation and understanding of the candidate.

Format for the report:

• Title sheet
• Department certificate
• Training certificate signed by industry authority
• Industry profile (Organization structure, Layout, functioning etc.)
• Manufacturing/Testing processes
• List of machineries with emphasis on special purpose machines
• Daily reports signed by competent industrial authority
• Training outcomes

(**Note:** Concern project guide should assess & sign the certificate)

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8. PROJECT PHASE – I

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Term Work: 50 marks
Oral: 50 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Identify the topic in the advanced areas of Automobile Engineering
- Review literature to identify gaps and define objectives and scope of the work
- Apply the ideas in the literature and develop research methodology
- Develop a model, experimental set-up and or computational techniques necessary

Term Work:

Number of students in a Batch may be up-to five.
Maximum 10 students shall work under the guidance of one faculty. The student will submit a progress report based on the project work undertaken by project group.
The term work under this, submitted by the student shall include –

1. Work diary maintained by the student and duly signed by his guide
2. The contents of work diary shall reflect the efforts taken by candidate for
   a. Searching the suitable project work
   b. Visits to different factories or organizations
   c. Brief report of journals and various papers referred
   d. Brief report of web sites seen for project work
   e. The brief of feasibility studies carried to come to final conclusion
   f. Rough sketches
   g. Design calculations, drawings etc. carried by the student.

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1. ALTERNATIVE FUELS AND EMISSION

Teaching Scheme:
Lectures: 3 hrs/week
Practical: 2 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)
Term Work: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Understand need of alternative Fuels with Their Sources with advantages and disadvantages
- Comprehend emission norms and regulations
- Illustrate sources and factors affecting the emissions from the SI and CI engines.
- Understand Emission Measurement, Test procedures and regulations, suitable cat-con for emission

1. Alternative Fuels and Their Sources: 6

Sources of fuels – Bio fuels , Edible & non edible vegetable oils, hydrogen, LPG, CNG, Bio gas, Methanol & Ethanol, Engine modification required to use alternative fuels, Dual fuel engine, Fuel efficiency, fuel requirement, rating of fuels, Hybrid drives. Production methods and availability of alternative fuels, Economics, Engine performance and Emission Characteristics with alternative fuels, Limitations.

2. Hydrogen and Fuel cells: 6

Properties of hydrogen with respect to its utilization as renewable forms of energy, sources of hydrogen, production, transportation, storage, application & economics of hydrogen**.** Principle of fuel cell, Types, Full cell for Automotive application (PEM), PEM fuel cell stack construction, performance.

3. Engine Emissions : 6

Automobile emission scenario, Sources of emission from vehicle, Formation of pollutants, CO, NOx, UBHC, Soot & Particulate formation, health effect of emission.

4. SI and CI engine Emission: 6

Emissions from SI engine, Compression ratio, equivalence ratio, Ignition timing, Mixture preparation, Residual gas dilution, engine speed, coolant temperature, fuel injection and in cylinder liquid fuel during warm up. CI engine emissions: Emissions from CI engine, Compression ratio, combustion chamber dead volumes, in cylinder air swirl, multi valves, fuel injection variables, engine load, engine speed.

5. Emission Measurement, Test procedures and regulations: 6

Test cycles for light & medium duty vehicles, test procedure for evaporative emissions, Emission standards for light and heavy duty vehicles & motor cycle emission standard. NDIR analyzers, FID, NOx analyzer, oxygen analyzer, smoke measurement, constant volume sampling, particulate emission measurement, Orsat apparatus.

6. SI and CI engine emission control technologies: 6

SI Engine: Engine design parameters, add on systems for after treatment of emissions with engine, thermal exhaust after treatment, catalytic exhaust after treatment, types of cat-con, ELCD

CI engine: Fuel injection variables, electronic fuel injection system, EGR, turbo charging, catalytic exhaust gas after treatment, diesel particulate filters.

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Termwork (Mini. Ten):

1. Study of Emission Norms
2. Measurement of emission by portable exhaust gas analyzer.
3. Measurement of emission by Infra Red Gas Analyzer (IRGA)
4. Measurement of smoke by Bosch smoke meter
5. Measurement of smoke by Hartridge smoke meter
6. Analysis of effect of Exhaust Gas Recirculation (EGR) on engine emission
7. Demonstration / Study of Evaporative Loss Control Device (ELCD)
8. Demonstration / Study of catalytic converter
9. Analysis of exhaust gas using Orsat Apparatus
10. Demonstration / Study of LPG Kit
11. Measurement of petrol engine emissions with the help of HC/CO analyzer
12. Study of Flame Ionization Detector.

Reference Books:

1. B. P. Pundir, Engine Emissions, Narosa Publications
2. E.F. Oberts, "Internal Combustion Engine and Air Pollution", Harper & Row Publisher, NY.
3. J.G. Giles, "Vehicle Operation & Testing" (Automotive Vehicle Technology Vol. 7)
4. C.H. Fisher, "Carburetion", Vol. 4.
5. A.W. Judge, "Carburetion and Fuel Injection System", Motor Manual, Vol. 2, The Caxton Pub. Co. Ltd., London.
6. H.H. Willard and Others, "Instrumental Method of Analysis", CBS Publishers & Distributors, Delhi.
7. G.B.S. Narang, "Automobile Engineering", CBS Publishers & Distributors, Delhi.
8. Gupta B. R., "Electronics & Instrumentation Handbook", Wheeler Publishing.
9. F. Schafar & R van Basshuysen, "Reduced emission and fuel consumption in automobile engine"Springer-Verlag Wien New York.
10. John k Pearson," Improving air quality".
11. Richard L.Bechtold , "Alternative Fuels Guidebook"
12. S.S.Thipse, "Alternative fuels"

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2. AUTOMOTIVE ELECTRONICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week	Theory Paper: 100 marks (3 hrs. duration)
Practical: 2 hrs/week	Term Work: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Identify the basic types of automotive wiring, types of terminals, and wiring diagrams.
- Describe the types, construction and operations of automotive battery along with ratings, performance, maintenance, and testing.
- Identify ignition and lightening accessory-circuit components, and state their functions
- Identify equipments & accessories, sensors and actuators and explain their functions

1. Battery 8

Requirement, Construction, Principle of operation, Working of Lead acid, alkaline, Zebra, Sodium Sulphur, Swing, batteries, Ratings, Charging, Maintenance & testing of Lead acid battery.

Fuel Cells

Introduction of Fuel Cells & fuel used, Constructions and Operation of proton Exchange membrane, Alkaline Fuel Cell. Medium & high temperature fuel cells, Reformers.

volt technology

Introduction, Transition from 12V to 42V electrical system, Need of 42V automotive electrical system. 42V automotive power system, Method of controlling 12V system in 42V architecture, Present developments in 42 volt technology.

2. Charging and Starting system 6

Requirements of charging system, Construction and Working of Regulators, Combined current & voltage regulator etc. Alternator - Principle of operation, Construction, Working, Rectification from AC to DC

Starting system

Requirements of starting system, Various torque terms used, Starter motors drives – Bendix, Folo through Barrel, Rubber compression, Compression spring, Friction clutch, Overrunning clutch, Dyer, Starter motor solenoids & switches, Integrated Starter and Alternator

3. Electronic Ignition System and Electronic Engine controls 6

Capacitor Discharge Ignition system, Distributer less Ignition System, Direct Ignition System, Hall Effect pulse generator, Inductive pulse generator, Constant dwell system, Constant energy system

Electronic Engine controls

Electronic control module (ECM), Operating modes of ECM (closed loop & open loop), Inputs required & output signals from ECM, Electronic spark timing, Electronic spark control, Air management system

4. Sensors & Actuators 7

Automotive Sensors - Thermisters, Inductive Sensors, Position Sensors (Rotary, Linear) Pressure Sensors, Knock Sensor, Optical Sensor, Hot wire & thin film air flow sensor, Turbine fluid flow sensors, Light sensor, Methanol sensor, Rain sensor operating

principles
Oxygen sensor, Application & new developments in sensor technology
Automotive Actuators - Introduction, Function & operating principle, Construction & working of solenoid actuators, Relays, Motorized actuators, Thermal Actuators, Electro hydraulic & Electrochemical Valve actuators, Application & new developments in the actuators technology, Stepper motors.

5. **Automotive Lighting and wiring harness systems.** 6
Lighting, Energy demand of lighting system, Types of Lamps, Reflectors, Gauges.
Accessories: Electric horn, wipers, Fuel pump, Power operated windows.
Wiring, Cables, Sizes, Colors and color codes, Connectors, Multiplex wiring system , CAN

6. Introduction to Automotive embedded system and Intelligent vehicle system. Telematics, X by wire, GPS etc. 3

Termwork: (Minimum ten)
1. Demonstration of automotive electrical and electronic systems layout
2. Demonstration of battery charging & battery testing
3. Demonstration and testing of alternators
4. Demonstration & testing of starting motors
5. Demonstration of electronic ignition system
6. Demonstration of dash board panel instruments & controls
7. Demonstration of headlight beam alignment
8. Testing of auto electrical components on multifunction tester
9. Testing of CDI coil, spark plug and armature
10. Demonstration of microcontroller 8051
11. Demonstration of electric bike and hybrid vehicle
12. Demonstration of ECU diagnostic system

References:
1. Tom Denton, 'Automobile Electrical & Electronic Systems', SAE International
2. Young, Griffithe, 'Automobile Electrical & Electronic Equipments', The English Language Book Co., London.
3. Bechfold SAE 1998, 'Understanding Automotive Electronics'.
4. V.A.W.Hilliers, 'Fundamentals of Automotive Electronics', Hatchin, London
5. Tomwather J. R., Cland Hunter, 'Automotive Computer & Control System', Prentice Inc. NJ
6. Robert N. Brandy, 'Automotive Computers & Digital Instrumentation', Prentice Hall Eaglewood, Cliffs, NJ
7. John Hartly, 'The Fundamentals of Electrical Systems', Longman Scientific & Technical
8. Wiliam B. Ribbens, 'Understanding Automotive Electronics', SAE International
9. P. L. Kohli, 'Automotive Electrical Equipments', Tata McGraw Hill Pub. Co. Ltd.
10. Henning Wallentowitz, Christian Amsel, '42 Volt Powernets'
11. Daniel J. Holt, '42 Volt Electrical system', SAE USA
12 Iqbal Hussain, 'Electric & Hybrid vehicles – Design fundamentals', CRC Press

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3. AUTOMOTIVE SYSTEM DESIGN

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week	Theory Paper: 100 marks (3 hrs. duration)
Practical: 2 hrs/week	Term Work: 25 marks
	Oral: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Design of Clutches for automotive application.
- Design of the gear box for automobiles
- Design of Axles & Propeller Shafts for the given specified data
- Apply the design procedure for various Suspension systems, brakes for the given specifications

1. Design of Clutches: 6

Design requirements of friction clutches, selection criterion, torque transmission capacity, lining materials, Design of single plate clutch, multi-plate clutch and centrifugal clutch.

2. Design of Gearbox: 6

Kinematic layout of gearbox, Selection of gear ratios & final drive ratio, centre distance Design of gears, shafts, splines and housing, selection of bearings, design considerations of gear shifter.

3. Design of Axles ,Propeller Shafts and Drive train: 6

Design of front & rear axles, Design of Propeller shafts for bending, torsion & rigidity and design of slip joints and U-joints, differential.

4. Design of Suspension System: 6

General design considerations of suspension system, Design of leaf springs and Helical compression for automobile suspension system, Design considerations of Belleville springs, Elastomeric springs, Air (Pneumatic) springs, design considerations of damper and telescopic suspension.

5. Brake Systems: 6

Design of Hydraulic Braking System, Internal Expanding Shoe Brake and Disc Brake.

6 Optimization: 6

Introduction to optimization of design, adequate and optimum design, methods of optimization, Johnson's method of optimization.

Term Work: (Minimum **two**)

1. Design & working details and assembly drawing of automotive clutch system.
   Shall comprise of:
   - Functional design of clutch
   - Design of clutch shaft, hub and flange
   - Design of damper springs
   - Design of sectors, rivets etc.
   - Design of pressure plate assembly
   - Design for linkage mechanism
   - Details and assembly drawing
2. Design & working details and assembly drawing of automotive gear box.
   Shall comprise of:
   - Calculation of gear ratios
   - Determination of number of teeth on gear pair
   - Determination of gear reductions
   - Design of gear pairs
   - Design of shafts
   - Selection of bearings
   - Details and assembly drawing
3. Design of automotive brake system.

References:

1. Joseph E. Shigley & Larry D. Mitchell, 'Mechanical Engineering Design', Fourth Edition, McGraw-Hill International Book Company.
2. Patil S.P., 'Mechanical System Design', 2nd edition, Jaico Publishers
3. M. F. Spotts & T.E. Shoup, 'Design of machine Elements', Seventh Edition, Pearson Education.
4. Bhandari V. B., 'Design of Machine Elements', Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Julian Happian – Smith, 'An Introduction to Modern Vehicle Design', Butterworth Heinemann
6. Pandya N.C.& Shah C.S., 'Elements of Machine Design', Twelth Edition, 1994, Charotar Publishing House.
7. R.C. Johnson, 'Optimum Design of Mechanical Elements', John Wiley & Sons.
8. J.S. Arora, 'Introduction to Optimum Design', McGraw-Hill Book Company Ltd.
9. N.K.Giri, 'Automotive Mechanics', khanna publication, 8 edition 2008

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4. VEHICLE PERFORMANCE AND TESTING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week	Theory Paper: 100 marks (3 hrs. duration)
Practical: 2 hrs/week	Term Work: 25 marks
	Oral: 25 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Recognize the importance of Vehicle Performance.
- Compare automotive clutches, geared transmission.
- Describe testing procedure of vehicle systems as tyre testing, brake testing.
- Identify active and passive safety systems.
- Explain causes and remedies for noise and vibration.

1. Vehicle performance parameters 6

Vehicle Performance parameters: Fuel economy, acceleration, deceleration, gradability, top speed, handling, comfort, life durability, EGR systems, Vehicular systems: Suspension, steering, Brakes & carriage unit testing, test procedure, Catalytic converters function &construction, Lambda close loop control system for gasoline vehicles.

2. Drive train and testing 6

Vehicular transmission performance: Characteristics and comparison of automotive clutches, Epicyclic transmission, Torque converter, testing of clutch, final drive and differential. Test procedure for gear box noise and shifting force.

3. Vehicle testing 6

Vehicle Testing - Road test, Free acceleration test, Coast down test, Wheel alignment and balancing test, Test tracks, proving ground testing, high speed track, pavement track, corrugated track, mud track, steering pad, gradient track, deep wading through shallow water, Laboratory testing, testing on chassis dynamometer, accelerated testing, Virtual testing, Oil consumption testing

4. Safety Systems and auxiliaries 6

Safety: Motor vehicle safety standards, active safety, passive safety, bio-mechanics Structural safety, energy absorption, ergonomic consideration in safety, Occupants safety systems like seat belts, head restrain, air bags, GPS , roll-over protection system, Electronic stability program.

5. Collisions and crash testing 6

Crash testing: Human testing, Dummies, crashworthiness, pole crash testing, rear crash testing, vehicle to vehicle impact, side impact testing, crash test sensors, sensor mounting, crash test data acquisition ,Braking distance test

6. Noise vibration and Automobile testing instrumentation 6

Noise & vibration: Mechanism of noise generation, engine noise & vibration, causes and remedies, road shocks wind noise & measurement, vehicle measurement testing.

Automobile testing instrumentation: Sensors – types and selection, Instrumentation for functional tests, component test, endurance test, model test and full scale test.

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Termwork: (Any Ten)

1. Estimation of power requirement or vehicle propulsion
2. Engine testing for finding performance characteristic
3. On road fuel consumption measurement of vehicle
4. Brake efficiency measurement
5. Noise measurement in passenger compartment
6. Vibration measurement in passenger compartment
7. Vehicle performance testing on chassis dynamometer.
8. Demonstration of vehicle component testing
9. Report based on visit to vehicle testing & research organization
10. Report based on visit to vehicle crash testing
11. Estimation of vehicle body moments.

Reference Books:

1. J. Y. Wong , Theory of Ground Vehicles, A wiley Interscience Publications
2. Hans Herman Braess, Ulrich Seiffert, Handbook of Automotive Engineering, SAE Publications
3. Rao V. Dukkipati, Jian Pang, Road Vehicle Dynamics, SAE Publications
4. Wolt, Heinrich Hucho, Aerodynamics of road vehicles, SAE Publications
5. Bosch, Automotive Handbook, SAE Publications
6. George Pieters Barbara Pieters, Automotive Vehicle Safety
7. Michel Plint Engine Testing Theory and Practice
8. Gousha H. M., "Engine performance Diagnosis & Tune Up Shop Manual"
9. J.G .Giles, "Vehicle Operation & Performance".
10. R. Venchatachalam, Mechanical Vibrations, PHI Publication, 1st Edn, 2014.
11. W. H. Crouse & D. L. Anglin, "Motor Vehicle Inspection".
12. SAE Transaction Papers – 831814/820346/820367/820371/820375

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5. ELECTIVE-II AUTOMOTIVE NOISE, VIBRATION AND HARSHNESS

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Explain basic concepts of noise, vibration and harshness and their effects.
- Analyze various methods of vibration control.
- Analyze sound sources and detection of noise from automobiles.
- Identify and analyze vibrations and noise arises from automobiles
- Investigate level of harm caused by noise and harshness and to provide measures to control it.

1. NVH in the automotive industry **6**

Sources of noise and vibration. Design features, common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and altering role of NVH engineers.

2. Sound and vibration theory **6**

Sound measurement, human sensitivity and weighting factors, combining sound sources. Acoustics resonance, properties of acoustics materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility, modes of vibration

3. Test Facilities and Instrumentation **6**

Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., sound intensity technique, acoustic holography.

4. Signal processing **6**

Sampling, aliasing and resolution. Statistical analysis, Frequency analysis, Campbell's plots, cascade diagrams, coherence and correlation functions.

5. NVH control strategies & comfort **6**

Source ranking, noise path analysis, modal analysis, design of experiments, optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators, active control techniques**.**

6. Statistical energy analysis **6**

Introduction, Need of S.E.A, modeling S.E.A., Evaluation of S.E.A. parameters,
Harshness – Causes , Frequency limits

References:

1. Norton M P, *Fundamental Of Noise And Vibration*, **Cambridge University Press**, 1989
2. Munjal M. L. *Acoustic Ducts and Mufflers*, **John Wilely**, 1987.
3. Baxa, *Noise Control of Internal Combustion Engines*, **John Wilely**, 1984.
4. Ewins D.J. *Model Testing: Theory and Practice*, **John Wiley,** 1995.
5. Boris and kornev, *Dynamic Vibration Absorbers*, **John Wiley**, 1993.
6. Mcconnell K, *Vibration Testing Theory and Practice*, **John Wiley**, 1995.
7. R. Venchatachalam, Mechanical Vibrations, PHI Publication, 1st Edn, 2014.
8. R. Lyon, "Statistical Energy Analysis", 1995.

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5. ELECTIVE-II: AUTOMOTIVE AERODYNAMICS

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Understand basics of fluid mechanics.
- Apply design concept of lift and drag on different shapes like circular, triangular etc.
- Calculating lift and drag of automotive models using

1. Introduction:
Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.

2. The Science of Aerodynamics:
Windshield angle, angular rotation, shear center, wheel rotation

3. Aerodynamic Drag of Cars:
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.

4. Shape Optimization of Cars:
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.

5. Vehicle Handling:
The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles.

6. Wind Tunnels for Automotive Aerodynamics:
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.

References:

1. W. H. Hucho, 2013, *Aerodynamics of Road Vehicles*, **Butterworth and Co**.
2. Schlichting H. 2007, *Boundary Layer Theory*, **McGraw Hill**, New York.
3 Pope A., 2009, *Low Speed Wind Tunnel Testing*, **John Wiley and Sons**, New York,.
4. Anderson J.D., 2011, *Fundamentals of Aerodynamics*, 5th ed., **McGraw Hill**, New York,.
5. Katz J. and Plotkin A., *Low Speed Aerodynamics*, **McGraw Hill**, New York.
6. Houghton E.L. and Brock A.E., 2007, *Aerodynamics for Engineering Students*, **Edward Arnold**, London.

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5. ELECTIVE-II FUELS, COMBUSTION AND EMISSION CONTROL

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Explain scope and history of combustion.
- Identify different combustion reactions.
- Study the liquid fuel combustion

1.	Combustion and energy- Conservation of mass, Thermodynamic Properties, Heats of reactions, First law for reactive systems	6
2.	Combustion and Entropy- Equilibrium and chemical reactions, Entropy, Gibbs and Helmholtz function, Equilibrium constants, Fuel cell	6
3.	Chemical Kinetics- Kinetic theory of gases, collision theory and chemical reactions, complex chemical kinetics mechanism, Basic flame theory	6
4.	Combustion Engine Testing – Indicated engine performance, Brake engine performance, Engine performance testing, Engine emission testing	6
5.	SI and CI Engine combustion – Themodynamics and Engine modeling, fuel thermo chemistry, combustion, engine fuel alternatives.	6
6.	Direct injection engine combustion, detonation of liquid – gaseous mixture, combustion of solid fuels.	6

Recommended Books :

1. Combustion Engineering – Gary L. Borman, Kenneth W. Ragland, McGraw Hill
2. Principles of Combustion – Kenneth K. Kuo, John Wiley & Sons
3. Fuels & Combustion – S. P. Sharma & Chander Mohan, Tata McGraw Hill
4. Fuels & Combustion – Sarkar
5. Applied Combustion – Eugene L. Keating

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5. ELECTIVE-II AUTOMOTIVE CONTROL SYSTEMS

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Describe automatic control systems.
- Describe block diagram algebra and control components
- Analyze transient response functions

1. **Introduction to Automatic Control**: Generalized Control System Types, Open Loop and Closed Loop, Linear and Non-Linear, Time Variant and Time invariant Systems with examples. Advantages of Automatic Control Systems
Mathematical Model of Control System: Mechanical Translational Systems, Rotational System, Grounded Chair Representation, Electrical Elements, Analogous Systems, Force – Voltage Analog, Force – Current Analog, Mathematical Model of Liquid Level System, Hydraulic/Pneumatic System, Thermal System, Gear Train — 6

2. **Block Diagram Algebra and Control Components**: Rules for Reduction of Block Diagram, Control System Components – Tachometer, D.C. Servomotor, Hydraulic Servomotor, Stepper Motor, Jet – Pipe Amplifier, Pneumatic Amplifier. — 6

3. **Transient Response:** General Form of Transfer Function, Concept of Poles and Zeros, Distinct, Repeated and Complex Zeros. Response of systems (First and Second Order) to Various Inputs (Impulse, Step, Ramp & Sinusoidal). Damping Ratio and Natural Frequency. Transient Response Specification. — 6

4. **Stability and Root Locus Technique:** Routh's Stability Criteria, Significance of Root Locus, Construction of Root Loci, General Procedure, Effect of Poles and Zeros on the System Stability. — 6

5. **State Space Analysis**: System Representation, Direct, Parallel, Series and General Programming, Conversion of State Space Model to Transfer Function. — 6

6. **Frequency Response Analysis:** Frequency Response Log Magnitude Plots and Phase angle Plots, Gain Margin, Phase Margin, Evaluation of Gain 'K', Polar Plots. System Compensation: Types of Compensators, Lead, Lag, Lead-Lag Compensators. — 6

REFERENCE BOOKS :

1. Control System Engineering: R Anandnatarajan, P. Ramesh Babu, SciTech Publi.
2. Control Systems: A. Anand Kumar, Prentice Hall Publi.
3. Automatic Control Engineering: F.H. Raven (5th ed.), Tata McGraw Hill Publi.
4. Modern Control Systems: K Ogata, 3rd Ed, Prentice Hall Publi.
5. **Automatic Control Systems**: Farid Golnaraghi and Benjamin C. Kuo, 9th Edition, Wiley Student Edition, Wiley Publication.
6. Automatic Control Engineering: D. Roy and Choudhari, Orient Longman Publi. Calcutta
7. Modern Control Engineering K.Ogata Pearson Education

Shivaji University, Kolhapur

B.E. (Automobile) Semester VIII (Revised)

5. ELECTIVE-II ENERGY ENGINEERING

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Theory Paper: 100 marks (3 hrs. duration)

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Identify different renewable energy systems.
- Explain latest trends in automobile sectors.
- Describe basic energy management terms.
- Define Geothermal and water energy conversions.

1. Introduction to Energy Engineering: 6

Introduction, Fossil fuel based systems, Renewable energy system, Relation between Energy, Man & Environment, Energy Terms- Energy Demand, Energy Consumption, Energy grid ,load curves-Daily and weekly , Impact of fossil fuel based systems, World & Indian energy scenario- Production and Consumption Status.

Solar Energy System:

-Solar potential, solar radiation spectrum, solar radiation geometry, solar radiation data, Radiation measurement, Technologies of thermal energy collection, Types of Solar Collectors, Collection efficiency, Testing of Solar collectors – IS code, Applications of Solar Energy, Solar Pond, Solar Energy storage & types.

-Operating Principle of Solar Photovoltaic systems, Photovoltaic cell concepts, Photo-cell materials, Cell module array, Series and parallel connections, applications related to automobiles.

2. Bio-Chemical Conversions: 6

-Introduction, Biological and Biochemical Conversion, Energy Plantation, Combustion and Fermentation anaerobic digester, Biomass gasification, Pyrolysis, various application of Biomass energy.

-Principle and working of H_2-O_2 fuel cell. Polarization in Fuel cell.

-Introduction to Nuclear Reactor Power Plant, Fast breeder reactor, boiling water Reactor.

3. Wind Energy: 6

Wind parameters and wind data, Wind Energy Terms: - Wind power density, Wind turbine Efficiency, Mean Wind Velocity, Energy Pattern factor, cut in, rated, mean wind speed, Site selection, Wind energy conversion systems and their classification, Construction and working of typical wind mill, characteristics of wind generators, Design considerations for wind mills, Merits and Demerits of wind energy conversion.

4. Geo-Water Energy: 6

-Types of geothermal resources, Methods of harnessing, Types of geothermal systems, environmental impact.

-Introduction to tidal, wave & OTEC and its types closed and open OTEC.

-Introduction to Hydro-electric scheme of power generation, Merits and Demerits.

5. Advance Trends in Energy & Automobiles: 6

- Need for Hybrid systems Range and type of hybrid systems, Case studies of Diesel-PV, Wind-PV cell., -Layout and working of Hybrid Electric Vehicles, Dual fuel systems, Concept of solar energy operated vehicles.

6. Energy Management: 6

-Concept of Energy planning, ECO-categories, ECM, Energy Strategy of India, Crucial issues of Energy planning in India, Rural Electrification, Waste Recycling Management.
- Concept of Energy Auditing, Types, Case studies related to automobile Industries.

Term Work:

1. Demonstration and measurement of solar radiation.
2. Demonstration / trial on solar flat plate collector.
3. Demonstration & Performance evaluation of PV cell.
4. Study and demonstration of fuel cell.
5. Layout and Demonstration of Battery Operated Vehicles.
6. Study & demonstration of energy storage devices.
7. Study & demonstration of Nuclear Reactor Power plant.
8. Energy Audit- Case study of Automobile Industry.
9. Study of Energy Distribution Models.
10. Industrial Visit to Renewable Energy Plant.

Reference Books:

1. Dr. S. P. Sukhatme, Solar Energy, Tata McGraw Hill.
2. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers.
3. S. Rao, Dr. B.B.Parulekar, Energy Technology, Khanna Publishers.
4. Dr. L. Umanan, Non-Conventional Energy Sources.
5. Raja, Introduction to Non-Conventional Energy Resources, SciTech Publi.

Shivaji University, Kolhapur
B.E. (Automobile) Semester VIII (Revised)
6. PROJECT PHASE – II

Teaching Scheme:
Practical: 4 hrs/week

Examination Scheme:
Term Work: 75 marks
Oral: 75 marks

COURSE LEARNING OUTCOMES: After completion of the course, the student shall be able to:

- Identify the materials and methods for carrying out experiments/develop a code.
- Reorganize the procedures with a concern for society, environment and ethics.
- Analyse, discuss and justify the results/trends and draw valid conclusions.
- Prepare the report as per recommended format and present the work orally adhering to stipulated time.
- Explore the possibility of publish/present a paper in conference without plagiarism.

Term Work:
The project work submitted by the student started at B.E. Part – I shall be according to following guidelines –
Format of project report –
The project report shall be typed with 1.5 line space on A4 size bond paper. The total number of pages shall not be more than 150 and not less than 60 including figures, graphs, annexures etc. as per requirement. The report shall be written in the following format -

1. Title sheet
2. Certificate
3. Acknowledgement
4. List of figures / graphs / tables/ photographs
5. Abbreviations
6. Abstract / Synopsis
7. Literature survey
8. Contents
9. Text with usual scheme of chapters
10. Discussion of the results and Conclusion
11. Bibliography

(The source of illustrative matter be acknowledged clearly at appropriate place)

The student/students has/have to present the project work in front of the faculty members of the department and his classmates. The faculty members, based on the quality of the work, preparation and understanding of the candidate, shall do an internal assessment of the project for his/their term work.

Shivaji University, Kolhapur

Equivalence for B.E.

(To be implemented from Academic year 2016-17)

Automobile Engineering Course

Semester- VII

Name of the Subject in Old Syllabus		Equivalent Subject for Examination from 2016-17	
1.	Engine & Machine Design	**1.**	I.C. Engine Design
2.	Vehicle Dynamics	**2.**	Vehicle Dynamics
3.	Finite Element Analysis	**3.**	Finite Element Analysis
4.	Alternative Fuels & Emission	**4.**	Alternative Fuels and Emission (Sem-VIII)
5.	Electives – I	**5.**	Elective-I
6.	Industrial Case Study Evaluation	**6.**	Automotive Industrial Training
7.	Engine Testing	**7.**	I.C. Engine Testing Lab
	Project Phase I		Project Phase-I

Semester – VIII

Name of the Subject in Old Syllabus		Equivalent Subject for Examination from 2016-17	
1.	Refrigeration & Air Conditioning	**1.**	Automotive Refrigeration and Air Conditioning (Sem- VI)
2.	Automotive Electronics	**2.**	Automotive Electronics
3.	Automotive System Design	**3.**	Automotive System Design
4.	Vehicle Performance	**4.**	Vehicle Performance and Testing
5.	Elective – II	**5.**	Elective-II
6.	Project	**6.**	Project Phase-II