AUTOMOTIVE CHASSIS & SUSPENSION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU61	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: The objectives of this course is to

1. Explain different chassis layouts and frames solve for stability and weight distribution and suitability of frames.
2. Describe, about various Front Axles, factors of wheel alignment Steering Systems and Calculate dimensions of Front Axle.
3. Discuss about various types Propeller Shaft, Differential And Rear Axles and tosolve numericals.
4. Compare various types of Brakes and solve numerical.
5. Describe Various Types of Suspensions, Wheels and Tyres.
6. Calculate dimensions of different suspensions.

Module-I	
Introduction: General consideration relating to chassis layout, power location, types of automobiles, layout of an automobile with reference to power plant, weight distribution, stability, Numerical problems. **Frames:** Types of frames ,general form & dimensions, materials, frame stresses, frame sections, cross members, proportions of channel sections, constructional details, loading points, sub frames, passenger car frames, X member type frame, Box section type frame, testing of frames, bending and torsion test, effect of brake application of frame stresses, truck frames, defects, Numerical problems.	10 Hours
Module-II	
Front axle and Steering systems: Axle parts and materials, loads and stresses, centre sections, section near steering head, spring pads, front axle loads, steering heads, factors of wheel alignment, wheel balancing, centre point steering, correct steering angle, steering mechanisms, cornering force, self righting torque, under steer and over steer, Steering linkages, steering gears, special steering columns, power steering, trouble shooting, Numerical problems.	10 Hours
Module-III	
Propeller shaft Construction & types of propeller shafts, whirling of propeller shaft, universal joints, analysis of Hooke's joint- ratio of shafts velocities, maximum & minimum speeds of driven shaft, condition for equal speeds of thee driving & driven shafts, angular acceleration of the driven shaft, maximum fluctuation of speed, double Hooke's joint, Numerical problems. **Final drive** Construction details, types. **Differential** Principle, types of differential gears, conventional and non-slip differentials,	10 Hours

backlash, differential lock, inter-axle differential, transaxle types. **Rear axle** Torque reaction, driving thrust, Hotchkiss drive, torque tube drive, construction of rear axle shaft supporting- fully floating and semi floating arrangements axle housings, trouble shooting, numericalproblems.	
Module-IV	
Brakes Necessity, stopping distance and time, brake efficiency, weight transfer, brake shoe theory, determination of braking torque, classification of brakes, types, construction, function, operation, braking systems - mechanical, hydraulic, disc, drum, details of hydraulic system, mechanical system and components, types of master & wheel cylinders, bleeding of brakes, brake drums, brake linings, brake fluid, factors influencing operation of brakes such as operating temperature, lining, brake clearance, pedal pressure, linkages etc, Brake compensation, Parking and emergency brakes, hill holder, automatic adjustment, servo brakes, Power brakes-Air brakes, vacuum brakes and electric brakes and components brake valve, unloaded valve, diaphragm, air-hydraulic brakes, vacuum boosted hydraulic brakes, trouble shooting, Numerical problems.	10 Hours
Module-V	
Suspension: Objects, basic considerations, Types of suspension springs, construction , operation & materials, leaf springs, coil springs, torsion bar, rubber springs, plastic springs, air bellows or pneumatic suspension, hydraulic suspension, constructional details of telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting, Numerical problems. **Wheels and Tyres:** Types of wheels, construction, structure and function, wheel dimensions, structure and function of tyres, static and dynamic properties of pneumatic tyres, types of tyres, materials, tyre section & designation, factors affecting tyre life, quick change wheels, special wheels, trouble shooting.	10 Hours

Course outcomes:

After completion of above course, students will be able to

1. Explain different chassis layouts and frames and solve for stability and weight distribution and suitability cross sectionsfor frames.
2. Describe various Front Axles, factors of wheel alignment Steering Systems and Calculate dimensions of Front Axle.
3. Describe various types Propeller Shaft, Differential and Rear axles and can find dimensions of these components.
4. Select type of brake required to given application and will be able to calculate basic dimension of brakes.
5. Describe, About Various Types of Suspensions, Wheels and Tyres.
6. Calculate dimensions of different suspensions.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Automotive Chassis- Heldt .P. M, Chilton Co., (Nyack, N.Y., P.M. Heldt, 1945) Literary Licensing, LLC, 2012.
2. Automotive Mechanics- N.K. Giri, 8th Edition , Khanna Publications, New Delhi,2008.

Reference Books:

1. Automobile Engineering Vol. I- Kirpal Singh, 12th edition, Standard publications, New Delhi, 2009.
2. Automobile Engineering - K. K. Ramalingam, Scitech Publication, Chennai – 2011.
3. Automotive chassis and body- P. L. Kohli, TMH.
4. Steering, Suspension and Tyres- Giles. J. G,Iiiffe Book Co., London- 1988.
5. Automotive Chassis and Body- Crouse W. H., McGraw-Hill, New York- 1971.
6. Automobile Engineering -T.R. Banga&Nathu Singh, Khanna Publications, 1993.
7. Introduction to Automobile Engineering - N.R. Khatawate, Khanna pub. New Delhi.

HEAT AND MASS TRANSFER

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU62	IA Marks	20
Number of Lecture Hours/Week	04+1T	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: The objectives of this course is to

1. Explain fundamental principles and laws of conduction, convection and radiation modes of heat transfer.
2. Analyze one dimensional steady state heat transfer.
3. Analyze one dimensional one dimensional unsteady state heat transfer.
4. Analyze one dimensional forced convection heat transfer problems.
5. Analyze one dimensional free convection heat transfer problems.
6. Analyze one dimensional application like flow over flat plate etc.
7. Introduce basic principle of heat exchanger analysis and thermal design.
8. Apply laws of radiation heat transfer to solve engineering problems.

Module-I	
Introductory concepts: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanism. Boundary conditions of 1^{st}, $2^{nd\ and\ 3rd}$ Kind, Conduction: Derivation of general three dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems. (No derivation). One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane and composite walls. Overall heat transfer coefficient. Thermal contact resistance, Numerical problems and Mathematical formulation.	10 Hours
Module-II	
Variable thermal conductivity Derivation for heat flow and temperature distribution in plane wall. Critical thickness of insulation without heat generation, Heat transfer in extended surfaces of uniform cross-section without heat generation, Long fin, and short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and effectiveness. Numerical problems. **One-dimensional transient conduction** Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Numerical Problems	10 Hours
Module-III	
Concepts and basic relations in boundary layers: Flow over a body velocity boundary layer; critical Reynolds number; general	

expressions for drag coefficient and drag force; thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer coefficient; Nusselt number. Flow inside a duct- velocity boundary layer, hydrodynamic entrance length and hydro dynamically developed flow; flow through tubes (internal flow)(discussion only). Numericals based on empirical relation given in data handbook **Free or Natural Convection:** Application of dimensional analysis for free convection- physical significance of Grashoff number; use of correlations free convection from or to vertical, horizontal and inclined flat plates, vertical and horizontalcylinders and spheres, Numerical problems. **Forced Convections:** Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro dynamically and thermally developed flows inside a duct use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical	10 Hours
Module-IV	
Heat Exchangers: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems. **Condensation and Boiling:** Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface; use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling pool boiling correlations. Numericals.	10 Hours
Module-V	
Thermal radiation: Definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement t law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Lambert's law; radiation heat exchange between two finite surfaces-configuration factor or view factor. Numerical problems.	10 Hours

Course outcomes: After completion of above course, students will be able to

1. Demonstrate fundamental principles and laws of conduction, convection and radiation modes of heat transfer.
2. Analyze one dimensional steady state heat transfer.
3. Analyze one dimensional one dimensional unsteady state heat transfer.
4. Analyze one dimensional forced convection heat transfer problems.
5. Analyze one dimensional free convection heat transfer problems.
6. Analyze one dimensional application like flow over flat plate etc.
7. Introduce basic principle of heat exchanger analysis and thermal design.
8. Apply laws of radiation heat transfer to solve engineering problems.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Heat transfer, by P.K. Nag, Tata McGraw Hill 2002.
2. Heat transfer-A basic approach, by Ozisik, Tata McGraw Hill 2002.

Reference Books:

1. Heat transfer, a practical approach-Yunus A- Cengel Tata McGraw Hill.
2. Principles of heat transfer by Kreith Thomas Learning 2001.
3. Fundamentals of heat and mass transfer by Frenk P. Incropera and David P. Dewitt, John Wileyand son's.
4. 4.Heat& Mass transfer-Tirumaleshwar,Pearson education 2006.

DESIGN OF MACHINE ELEMENTS -II

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU63	IA Marks	20
Number of Lecture Hours/Week	04 +1T	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: The objectives of this course is to

1. Describe the basic types of curved beams and springs.
2. Analyze the stresses in the critical section of a curved beam.
3. Illustrate the design procedure to arrive at the proper specifications of springs/gears/clutches.
4. Select suitable size, module & type of gears for a required velocity ratio.
5. Calculate the dimensions and suggest suitable materialsfor Gears.
6. Define the terminology of gears and springs.
7. Demonstrate the suitability of a type and class of lubricant for a specific application.

Module-I	
Bending stresses in curved beams: Introduction, Analysis of stresses in curved beams, stresses in beams of standard cross sections. **Springs** Introduction, types of springs, terminology, stresses and deflection in helical coil springs of circular and non-circular cross sections, springs under fluctuating loads, concentric springs. Leaf Springs: stresses in leaf springs, equalized stresses, length of spring leaves.	10 Hours
Module-II	
Spur & helical gears: Introduction, spur gears, standard proportions of gear systems, stresses in gear tooth, Lewis equation and form factor, design for strength, dynamic load and wear load. Helical Gears: definitions, formative number of teeth, design based on strength, dynamic and wear loads.	10 Hours
Module-III	
Bevel and Worm Gear: Terminology, formative number of teeth, design based on strength, dynamic and wear loads. Worm Gears: terminology, design based on strength, dynamic, wear loads and efficiency of worm gear drives.	10 Hours
Module-IV	
Clutches &Brakes: Introduction, types of clutches, design of Clutches (single plate, multi plate clutches). Brakes, energy absorbed by a brake, heat dissipated during braking, single block brakes and simple band brakes.	10 Hours
Module-V	
Sliding bearings:	10 Hours

Introduction, principle of hydro dynamic lubrication, assumptions in hydrodynamic lubrication, bearing characteristic number and modulus, Sommerfeld number, coefficient of friction, power loss, heat Generated and heat dissipated, selection of lubricant, grease, bearing failure- causes and remedies, design of journal bearings. **Rolling contact bearings:** Types of bearings, Principleof self-aligning, static equivalent load, dynamic load rating,bearing life, selection of ball and roller bearings, advantages and disadvantages of ball, roller and needle bearings, lubrication of bearing.	

Course Outcomes:

After completion of above course, students will be able to

1. Design the curved beams using the equations of stress.
2. Design helical spring and leaf spring using the equations of stress and deflection.
3. Design the spur gears and helical gears using different parameters and check the gears for dynamic and wear load.
4. Design the various types of bevel gears and worm gears for dynamic and wear load using various parameters.
5. Design sliding contact and rolling contact bearings to find coefficient of friction, heat generated, heat dissipated and average life of bearings.
6. Analyze and design given machine components and present their designs in the form of a Report.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Design Data Hand Books:

1. Design Data Hand Book by K. Mahadevan and K.Balaveera Reddy, CBS, Publication.
2. Design Data Hand Book – K. Lingaiah, McGraw Hill, 2nd Ed. 2003.

Text Books:

1. Mechanical Engineering Design- Joseph E Shigley and Charles R. Mischke McGraw Hill International edition, 2003.
2. Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., NewDelhi, 2nd Edition 2007.

Reference Books:

1. Machine Design- Robert L. Norton, Pearson Education Asia, 2001.
2. Mechanical Engineering Design-Joseph E Shigley and Charles R. Mischke, McGraw Hill Internationaledition, 6th Edition 2003.
3. Machine Design-Hall, Holowenko, and Laughlin (Schaum's Outlines series) Adapted by S. K. Somani,Tata McGraw Hill Publishing Company Ltd.
4. Machine Design-II-J.B.K. Das, SapnaBook House, Bangalore.

AUTOMOTIVE TRANSMISSION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU64	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives:The objectives of this course is to

1. Explain the Constructional, design and working principles of different types of clutches.
2. Explain the constructional and working principle of different types of fluid flywheel, torque converter and one way clutches.
3. Explain the constructional and working principle of different types of gear box.
4. Determine the gear ratio, speed of vehicle and number of teeth on driving and driven gears.
5. Explain the constructional and principle of operation of different types epicyclic gear box, Calculationof gear ratio for epicyclic gear box.
6. Explain the necessity, advantages, constructional and principle of operation of different types of automatic transmissions and hydraulic control.

Module-I	
Clutch: Necessity of clutch in an automobile, requirements of a clutch, Clutch materials, clutch lining,different types of clutches, friction clutches-Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches,Vacuum operated clutch, Clutch adjustment, Clutch troubles and their causes, Numerical problems.	10 Hours
Module-II	
Fluid Coupling & One way clutches: Constructional details of various types, percentage slip, one way clutches (Over running clutch) like sprag clutch, ball and roller one way clutches, necessity and field of application, working fluid requirements, fluid requirements, fluid requirements and fluid coupling characteristics. **Hydrodynamic Torque converters:** Introduction to torque converters, comparisons characteristics, slip, principles of torque multiplication, 3 and 4 phase torque converters, typical hydrodynamic transmission.	10 Hours
Module-III	
Power Required for Propulsion: Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration gradeability, drawbar pull, Numerical Problems. **Transmission:** The need for transmissions, Necessity of gear box, Calculation of gear ratios for vehicles, Performance characteristics in different gears , Desirable ratios of 3speed & 4speed gear boxes, Constructional details of - Sliding-mesh gear box, Constant-mesh gear box, Synchromesh gear box, auxiliary transmissions, compound transmissions, numerical problems.	10 Hours
Module-IV	

Epicyclic Transmission: Principle of operation, types of planetary transmission, Calculation of gear ratio in different speeds, Wilson planetary transmission, Ford-T model gear box , Pre selective mechanism, Vacuum control, pneumatic control, hydraulic control in the planetary gear system , Over drives , Numerical problems.	10 Hours
Module-V	
Hydrostatic Drives: Principles of hydrostatic drives, different systems of hydrostatic drives, constant displacement pump and constant displacement motor, variable displacement pump and constant displacement motor and variable displacement motor, variable displacement pump and variable displacement motor, applications, plunger type pump and plunger type motor, advantages and limitations, typical hydrostatic drives, hydrostatic shunt drives. **Automatic transmission:** Principle, general description and Working of representative types like Borge-warner, 4-speed and 6-speed automatic transmission longitudinally mounted four speed automatic transmission, hydramatic transmission, the fundamentals of a hydraulic control system, basic four speed hydraulic control system.	10 Hours

Course outcomes:

After completion of above course, students will be able to

1. Explain the Constructional, design and working principles of different types of clutches.
2. Explain the constructional and working principle of different types of fluid flywheel, torque converter and one way clutches.
3. Explain the constructional and working principle of different types of gear box.
4. Determine the gear ratio, speed of vehicle and number of teeth on driving and driven gears.
5. Explain the constructional and principle of operation of different types epicyclic gear box, Calculate gear ratio for epicyclic gear box .
6. Explain the necessity and advantages of automatic transmission.
7. Explain the constructional and principle of operation of different types of automatic transmissions and hydraulic control.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text books:

1. Automotive Mechanics-N.K. Giri,Khanna Publication, New Delhi, 2014.
2. Advanced Vehicle Technology, Heinz Heisler, 2002.

Reference books:

1. Automotive Transmissions and Power trains- Crouse W.H., McGraw Hill Co. 5thedn, 1976.
2. Motor Vehicle- Newton K and Steeds. W., Butter Worth's & Co. Publishers Ltd, 1997.
3. Automobile Engineering –. Vol.1- Kirpal Singh, Standard Pub. 2011.
4. Automobile Engineering- G. B. S. Narang, Khanna publication, New Delhi.

5. Automotive mechanics - Joseph I Heitner, Affiliated East West Press, NewDelhi.
6. Fundamentals of Automatic Transmission - William HasselBee.
7. Torque converters- P.M. Heldt,, Oxford & IBH, 1975.

ROBOTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU651	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives:The objectives of this course is to

1.Explain basics of robots.
2.Analyze motions of robotic manipulator.
3.Analyze dynamics of robotic arm.
4.Describe different types of sensors and actuators.
5.Explain controls of robots.

Module-I	
Introduction and Mathematical Representation of Robots: History of Robots, Types of Robots, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Euler Angles For fixed frames X-Y-Z and moving frame ZYZ, Transformation between coordinate system, Homogeneous coordinates, Properties of A/BT, Types of Joints: Rotary, Prismatic joint, Cylindrical joint, Spherical joint, Representation of Links using Denvit-Hartenberg Parameters: Link parameters for intermediate, first and last links, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator.	08 Hours
Module-II	
Kinematics of Serial Manipulators: Direct kinematics of 2R, 3R, RRP, RPR manipulator, puma560 manipulator, SCARA manipulator, Stanford arm, Inverse kinematics of 2R, 3R manipulator, puma560 manipulator. **Velocity and Statics of Manipulators:** Differential relationships, jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain.	08 Hours
Module-III	
Dynamics of Manipulators: Kinetic energy, Potential energy, Equation of motion using Lagrangian, Equation of motions of one and two degree freedom spring mass damper systems using Lagrangian formulation, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian, Newton-Euler formulation.	08 Hours
Module-IV	
Trajectory planning: Joint space schemes, cubic trajectory, Joint space schemes with via points,	08 Hours

Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning. **Robot Control:** Feedback control of a single link manipulator- first order, second order system, PID control, PID control of multi-link manipulator, Force control of manipulator, force control of single mass, Partitioning a task for force and position control- lever, peg in hole Hybrid force and position controller.	
Module-V	
Robot Actuators: Types, Characteristics of actuating system: weight, power-to-weight ratio, operating pressure, stiffness vs. compliance, Use of reduction gears, comparison of hydraulic, electric, pneumatic, actuators, Hydraulic actuators, proportional feedback control, Electric motors: DC motors, Reversible AC motors, Brushles DC motors, Stepper motors- structure and principle of operation, stepper motor speed-torque characteristics. **Robot Sensor:** Position sensors- potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor- encoders, tachometers, Acceleration sensors, Force and Pressure sensors – piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, optical , ultrasonic, inductive, capacitive, eddy-current proximity sensors.	08 Hours
Course outcomes: After completion of above course, the student will be able to 1.Explain basics of robots. 2.Analyze motions of robotic manipulator. 3.Analyze dynamics of robotic arm. 4.Choose different types of sensors and actuators. 5.Explain robot control.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. Fundamental concepts and analysis of robots-Ghosal A., Oxford, 2006. 2. Introduction to Robotics Analysis, Systems, Applications- Niku, S. B., Pearson education, 2008.	
Reference Books: 1. Introduction to Robotics- Mechanics and Control, Craig, J.J., 2nd edition, Addison-Welsey, 1989. 2. Fundamentals of Robotics, Analysis and Control- Schilling R.J., PHI, 2006.	

EXPERIMENTAL STRESS ANALYSIS

[as per choice based credit system (CBCS) scheme]

Semester – VI

Subject Code	15AU652	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives:The objectives of this course is to

1. Explain different types of stain gauges and performance characteristics of stain gauge circuits.
2. Describe application of photo elasticity.
3. Explain different separationmethods.
4. Analyze coating stresses.
5. Analyze brittle coating stresses and explain calibration of coating.

Module-I	
Electrical Resistance Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, StrainGage circuits. **Strain Analysis Methods:** Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.	08 Hours
Module-II	
Photo-elasticity: Nature of light, Wave theory of light - optical interference ,Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics&Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photoelastic model materials.	08 Hours
Module-III	
Two Dimensional Photo-elasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials **Three Dimensional Photo elasticity**: Stress freezing method, Scatteredlight photo-elasticity, Scattered light as an interior analyzer and polarizer,Scattered light polariscope.	08 Hours
Module-IV	
Photoelastic (Birefringent) Coatings: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence, Strip coatings.	08 Hours
Module-V	
Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.	08 Hours

Moire Methods:

Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, out of plane displacement measurements, Out of plane slope measurements .Applications and advantages.

Course outcomes:

After completion of above course, the student will be able to

1. Explain different types of stain gauges and performance characteristics of stain gauge circuits.
2. Describe application of photo elasticity.
3. Explain different separationmethods.
4. Analyze coating stresses.
5. Analyze brittle coating stresses and explain calibration of coating.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Experimental Stress Analysis-Dally and Riley, McGraw Hill.
2. Experimental Stress Analysis-Sadhu Singh, Khanna publisher.
3. Experimental stress Analysis-Srinath L.S,Tata McGraw Hill.

Reference Books:

1. PhotoelasticityVol. I and Vol. II-M.M.Frocht, John Wiley &sons.
2. Strain Gauge Primer-Perry and Lissner.
3. Photo Elastic Stress Analysis-Kuske, Albrecht &Robertson, John Wiley & Sons.

COMPOSITE MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

Subject Code	15AU653	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives:the objective of this course is to

1. Explain basic concepts of composite materials and application of composite material in various engineering fields.
2. Describe various FRP processing.
3. Describe selection, requirements for production and application of MMC.
4. Explain students to various techniques used for MMC production.
5. Describe concepts of nano materials, nano technology and use of nano materials.
6. Analyse micro mechanical properties of lamina using various approaches.
7. Explain basics of NC, CNC, Robots and their applications.

Module-I	
Introduction to composite Materials: Definition, classification and characteristics of composite materials -fibrous composites, laminated composites, particulate composites. Properties and types of Reinforcement and Matrix materials. **Application of composites** Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.	08 Hours
Module-II	
Fibre reinforced plastic processing: Layup and curing, fabricating process – open and closed mould process – hand layup techniques – structural laminate bag molding, production procedures for bag molding – filament winding, pultrusion, pulforming, thermo – forming, injection, injection molding, liquid molding, blow molding.	08 Hours
Module-III	
Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals, Need for production, MMC's and its application. **Fabrication Process for MMCs:** Powder metallurgy technique and itsapplication, liquid metallurgy technique and its application and secondary processing, special fabrication.	08 Hours
Module-IV	
Properties of MMCs: Physical, mechanical,wear,machinability and other properties. Effect of size, shape and distribution of particulate on properties. **Nano-materials:** Introduction, types of nano materials, synthesis nanomaterial using Chemical vapor depositions, physical vapor deposition, phase transformation of nanoparticles, magnetic, optical, electrical and mechanical properties of nanoparticles.	08 Hours

Module-V	
Micromechanical Analysis of a Lamina: Introduction, evolution of four elastic moduli by strength of material approach, rule of mixture, Numericals. **Mechanics of Lamina:** Hooks law for different types of materials, number elastic constants, two dimensional relationship of compliance and stiffness matrix.	08 Hours

Course outcome:

After completion of above course, the student will be able to

1. Describe basic concepts of composite materials and application of composite materials in various engineering fields.
2. Describe various FRP processing.
3. Describe selection, requirements for production and application of MMCs.
4. Describe concepts of nano materials, nano technology and use of nano materials.
5. Use various techniques used for MMCs production.
6. Analyze micro mechanical properties of lamina using various approaches.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Composites Science and Engineering - K. K. Chawla, Springer Verlag.
2. Introduction to composite materials- Hull and Clyne, Cambridge University Press , 2nd edition , 1990.
3. Nano-materials- An introduction to synthesis, properties and applications- Dieter vollathWiley VCH , 2nd edition, 2013.

Reference Books:

1. Composite materials Hand Book- 1984- MeingSchwaitz, McGraw Hill Book Company.
2. Mechanics of Composite Materials- Robert M. Jones, McGraw Hill Kogakusha Ltd.
3. Forming Metal hand book, 9th edition, ASM handbook, V15. 1988, P327- 338.
4. Mechanics of composites- Artar Kaw, CRC Press. 2002.
5. Composite Materials - S.C. Sharma,Narosa publishing House, New Delhi 2000.
6. Principles of Composite Material mechanics- Ronald .F. Gibron, McGraw Hill. International, 1994.

AUTOMOTIVE POLLUTION AND CONTROL
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI

Subject Code	15AU654	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: The objectives of this course is to

1. Explain air pollution and pollutants, their sources & their effects.
2. Describe different parameters responsible for pollutant formation.
3. Choose instruments for pollution measurements.
4. Analyze measurement of pollutants.

Module-I	
Laws and regulations: Historical background, regulatory test procedure (European cycles), Exhaust gas pollutants (European rail road limits), particulate pollutants, European statutory values, inspection of vehicle in circulation (influence of actual traffic conditions and influence of vehicle maintenance). **Effect of air pollution:** Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants.	08 Hours
Module-II	
Mechanism of pollutant formation in Engines: **Nitrogen oxides:** Formation of nitrogen oxides, kinetics of NO formation, formation of NO_2, NO formation in spark ignition engines, NO_x formation, in compression ignition engines. **Carbon monoxide:** Formation of carbon monoxide in SI and CI Engines. **Unburned Hydrocarbons:** Back ground, flame quenching and oxidation fundamentals, HC emissions from spark ignition engines, HC emission mechanisms in diesel engines. **Particulate emissions:** Spark ignition engine particulates, characteristics of diesel particulates, soot formation fundamentals, soot oxidation. **Crankcase emissions, piston ring blow by, evaporative emissions.**	08 Hours
Module-III	
Pollution control techniques: Pollution control measures inside SI Engines & lean burn strategies, measures in engines to control Diesel Emissions Pollution control in SI & CI Engines, Design changes, optimization of operating factors and Exhaust gas recirculation, fuel additives to reduce smoke & particulates, Road draught crankcase ventilation system, positive crankcase ventilation system, fuel evaporation control. **Influence of Fuel Properties** Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions.	08 Hours

Module-IV	
Post combustion Treatments: Available options, physical conditions & exhaust gas compositions before treatment, Catalytic mechanism, Thermal Reactions, Installation of catalyst in exhaust lines, catalyst poisoning, catalyst light-off, NO_x treatment in Diesel Engines, particulate traps, Diesel Trap oxidizer.	08 Hours
Module-V	
Sampling procedures: Combustion gas sampling: continuous combustion, combustion in a cylinder Particulate sampling: soot particles in a cylinder, soot in exhaust tube, Sampling Methods-sedimentations, and filtration, and impinge methods-electrostatic precipitation thermal precipitation, centrifugal methods, determination of mass concentration, analytical methods- volumetric-gravimetric-calorimetric methods etc. **Instrumentation for pollution measurements:** NDIR analyzers, Gas chromatograph, Thermal conductivity and flame ionizationdetectors, Analyzers for NO_x, Orsat apparatus, Smoke measurement, comparison method, obscurationmethod, ringelmann chart, Continuous filter type smoke meter, Bosch smoke meter, Hart ridge smoke meter.	08 Hours

Course outcome:

After completion of above course, the student will be able to

1. Explain air pollution and pollutants, their sources & their effects.
2. Describe different parameters responsible for pollutant formation.
3. Choose instruments for air pollution measurement.
4. Analyze measurement of pollutants.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Automobiles and pollution - Paul degobert (SAE)
2. Internal combustion engine fundamentals-John B. Heywood, McGraw Hill Book publications, 1998.

Reference Books:

1. Internal combustion engines-V. Ganesan, Tata McGraw Hill Book Company, 1995.
2. Automotive Emission Control- Crouse William, Gregg Division /McGraw-Hill. 1980.
3. Combustion Generated Air Pollutions - Ernest, S., Starkman, Plenum Press, 1980.
4. Engine emissions, Pollutant Formation and Measurement- George, Springer and Donald J.Patterson,, Plenum press, 1972.
5. Internal Combustion Engines and Air Pollution- Obert, E.F.,Intext Educational Publishers, 1980.

AUTOMOTIVE CHASSIS COMPONENTS LAB

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –VI

Subject Code	15AUL 57	IA Marks	20
Number of Lecture Hours/Week	01I + 02P	Exam Marks	80
Total Number of Lecture Hours	39	Exam Hours	03
Credits	02		

Course objectives:the objectives of this course is to

1. Explain how to identify the various chassis frames of cars, bus (front engine & rear engine), truck and articulated vehicles.
2. List specifications of different two and four wheeled vehicles.
3. Describe procedure for Disassemble / assemble, cleaning, inspection and servicing of chassis sub-systems like suspension, clutch / gear box, final drive / differential, brake, steering and tyres / wheels.

PART – A

1. Writing technical specification of two wheeled and four wheeled vehicles (at least 10 vehicles)
2. Drawing the layouts of chassis frames of cars, bus (front engine & rear engine), truck and articulated vehicles
3. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of single plate clutch and multi plate clutch. Checking the clutch springs and Clutch adjustments.
4. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of different types of gear box and calculation of gear ratios.
5. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of propeller shaft assembly including universal joint and slip joint.

PART-B

1. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of final drive and differential.
2. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of steering system and steering gears.
3. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of braking system, bleeding in hydraulic brakes
4. Removing the wheels from the vehicle, inspection for wear of tyre tread, inspection of tube, vulcanizing the tube, refitting of wheel on vehicle
5. Disassembling, cleaning, inspection for wear and tear, servicing and assembling of front independent suspension, shock absorber and leaf spring suspension system

Course outcome:

At the end of this laboratory, students will be able to:

1. Identify the various chassis frames of cars, bus (front engine & rear engine), truck and articulated vehicles.
2. List specifications of different two and four wheeled vehicles.
3. Disassemble / assemble, clean, inspect and service chassis sub-systems like suspension, clutch / gear box, final drive / differential, brake, steering and tyres / wheels.

Scheme of Examination:

One Question from Part – A	30 marks
One Question from Part – B	40 marks
Viva – Voce	10 marks
Total:	**80 marks**

ENGINE TESTING AND EMISSION MEASUREMENT LABORATORY

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –VI

Subject Code	15AUL 58	IA Marks	20
Number of Lecture Hours/Week	01I + 02P	Exam Marks	80
Total Number of Lecture Hours	39	Exam Hours	03
Credits	02		

Course objectives:the aim of this course is to

1. Explain and hands on experience for conduction of tests on various engines for determination of performance characteristics.
2. Describe procedure to Morse test on multi cylinder engine for finding FP, IP, BP.
3. Provide opportunity for conduction of tests on various engines with alternative fuels like alcohols, bio diesel for verifying their suitability for Internal combustion engines
4. Explain and hands on experience for conduction of mission tests on various engines.

PART – A	
1. Performance test on Single Cylinder and multi cylinder SI / CI engines 2. Study on SI and CI engines performance by changing parameters like valve timing, ignition timing, compression ratio, etc 3. Morse test on multi cylinder engine for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency. 4. Study of engine performance using alternate fuels like alcohol blends/ bio diesel / LPG.	
PART-B	
1. Study and testing on MPFI Engine and Variable compression ratio Engine. 2. Tuning of engines using computerized engine analyzer. 3. Exhaust Emission test of S. I.Automotive engine. 4. Exhaust Emission test of C. I. Automotive engine.	

Course outcome:

At the end of this laboratory, students will be able to:

1. Determination of performance characteristics of various types of engines.
2. Determine finding FP, IP, BP of multi Cylinder engines by conducting Morse test.
3. Verify suitability of various alternative fuels for internal combustion engines.
4. Conduct mission tests on various engines.

Scheme of Examination:

One Question from Part – A 30 marks
One Question from Part – B 40 marks
Viva – Voce 10 marks
Total: 80 marks