MATERIAL SCIENCE AND METALLURGY

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

SEMESTER – III

Subject Code	15AU32	Exam Marks	80
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Credits	04
IA Marks	20		

Course objectives:

The objectives of this course are to make students:

1. To gain knowledge of different material crystal structures, arrangement of atoms and mechanical properties.
2. To know different types of fractures and their importance.
3. To draw TTT curves and Iron carbon diagrams
4. To select various non-ferrous metals and alloys based on composition and properties for a given application
5. To describe various types of composite materials, explain various manufacturing methods of composites and identify the engineering application.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections –point, line and surface imperfections. Atomic Diffusion: Phenomenon, Flick's laws of diffusion, factors affecting diffusion. **Mechanical Behavior**: Stress-strain diagram for ductile and brittle materials, True stress and true strain, linear and non linear elastic behavior and properties, mechanical properties in plastic range, yield strength, offset yield strength, ductility, ultimate tensile strength, and toughness. Plastic deformation of single crystal by slip and twinning.	10 Hours	L1, L2
Module -2		
Fracture: Type I, Type II and Type III. **Creep:** Description of the phenomenon with examples, three stages of creep, creep properties, stress relaxation. **Fatigue:** Types of fatigue loading with examples, Mechanism of fatigue,	10 Hours	L1, L2

fatigue properties, fatigue testing and S-N diagram.		
Module -3		
Solidification and Solid Solutions: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures, solid solutions- types and rules governing the formation of solid solutions. **Phase Diagram:** Basic terms, phase rule, lever rule, cooling curves, construction and interpretation of different phase diagrams (eutectic, eutectoid, peritectic and peritectoid)	10 Hours	L1, L2, L3
Module -4		
Heat Treatment of Metals: TTT curves, continuous cooling curves, annealing and its types. normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flarne hardening and induction hardening, age hardening of Aluminium-copper alloys. **Ferrous Materials**: Properties, Composition and uses of Grey cast iron, malleable iron, S.G iron and steel **Non Ferrous Metals:** Copper alloys-brasses and bronzes. Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys.	10 Hours	L1, L2, L3, L4
Module -5		
Composite Materials: Definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP' and MMC's advantages and application of composites. **Other Materials:** Brief description of other materials such as optical and thermal materials Smart materials – fiber optic materials, piezo-electrics, shape memory alloys Shape Memory Alloys – Nitinol, superelasticity, Biological applications of smart materials - materials used as implants in human Body, Selection of Materials, Performance of materials in service Residual life assessment – use of non-destructive testing, Economics, Environment and Sustainability.	10 Hours	L2, L3

Course outcomes:

At the end of this course student will be able to:

1. Explain different types of material crystal structures and arrangement of atoms.
2. Describe various mechanical properties of materials.
3. Describe about different types of fractures and their importance in engineering applications.
4. Explain the concept of equilibrium diagram.
5. Plot cooling curves and phase diagrams for pure metals and alloys.
6. Draw and Interpret TTT curves and Iron carbon diagram.
7. Explain various heat treatment processes and their importance in engineering field.
8. Identify various ferrous metals and alloys based on composition and properties for prescribed application .
9. Select various nonferrous metals and alloys based on composition and properties for given application.

10. Describe about different types of composite materials and their production and application in engineering field.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

TEXT BOOKS:

1. Smith, **Foundations of Materials Science and Engineering**, 3rd Edition McGraw Hill, 2009
2. Shackleford., & M. K. Muralidhara, **Materials Science**, Pearson Publication – 2007.

Reference Books:

1. Alan Cottrell, **An introduction to Metallurg**y, University Press India Oriental Longman Pvt. Ltd., 1974.
2. V.Raghavan, **Materials Science and Engineering**, PHI, 2002
3. H. VanVlack, **Elements of Materials Science and Engineering,** Addison- Wesley Edn., 1998
4. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons. Inc, 5th Edition, 2001.
5. Donald R. Askland and Pradeep.P. Phule, **The Science and Engineering of Materials**, Thompson Learning, 4lh Ed., 2003.

ENGINEERING THERMODYNAMICS

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

SEMESTER – III

Subject Code	15AU33	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Number of Tutorial Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	50	Credits	04

Course objectives:

The objectives of this course are to make students:

1. To define work, heat, and laws of thermodynamics.
2. To explain the concept of entropy
3. To calculate load and IHP, BHP of IC engines
4. To evaluate thermal performance of refrigeration cycles
5. To demonstrate the calculation of efficiency of gas power and vapor power cycles
6. To design cost effective thermodynamic systems

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Fundamentals of Thermodynamics: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer **Work and Heat:** Thermodynamic definition of work; examples, sign convention, Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention.	10 Hours	L1, L2
Module -2		
Laws of Thermodynamics and Entropy Joules experiments, Statement of the First law of thermodynamics, steady state-steady flow energy equation, important applications, analysis of unsteady processes such as filling and evacuation of vessels	10 Hours	L1, L2

with and without heat transfer. Keivin –Planck & Clasius statement of Second law of Thermodynamics, PMM II and PMM I. Clasius Theorem & inequality, Entropy; definition, a property, Available and unavailable energy, Numericals.		
Module -3		
Combustion Thermodynamics, Gas power cycles and Testing of IC Engines: Air Fuel (A/F) ratio, Excess air, Theoretical (Stoichiometeric) air for combustion of fuels, Exhaust gas analysis , Otto, Diesel, Dual Cycles, efficiencies and mean effective pressures, Testing of two stroke and four stroke SI and CI engines for performance Related numerical problems, heat balance sheet, Morse test, Willian line test and Motoring Test.	10 Hours	L1, L2, L3
Module -4		
Refrigeration and Psychrometry Vapor absorption refrigeration system, steam jet refrigeration, vapor compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties. Dry bulb temperature, wet bulb temperature, dew point temperature; specific and relative humidifies Construction and use of psychrometric chart Analysis of various processes; heating, cooling, dehumidifying and humidifying. Adiabatic mixing of moist air. Summer and winter air conditioning. Numericals.	10 Hours	L1, L2, L3, L4
Module -5		
Reciprocating Air Compressors, Gas Turbine and Jet Propulsion: Operation of a single stage reciprocating compressor, work input through P-V diagram, steady state and steady flow analysis, adiabatic, isothermal and mechanical efficiencies minimum work for compression, multistage compressor. Classification of Gas turbines, Analysis of open cycle gas turbine cycle. Advantages and disadvantages of closed cycle, numericals. Principle of Jet propulsion and Rocket propulsion	10 Hours	L2, L3
Course outcomes: At the end of this course student will be able to: 1. Define and explain fundamental thermodynamic laws and concepts, work, various types of works and heat and its applications, entropy and its relations 2. Explain Zeroth, First & Second law of thermodynamics and its applications. 3. Explain various thermodynamic relations, constants of gas and basics of ideal gas & its mixtures. 4. Calculate load and IHP, BHP of IC engines. 5. Explain the selection of air conditioning system; evaluate thermal performance of refrigeration		

cycles.

6. Calculate efficiency and MEP of various gas power & vapor power cycles.
7. Explain the principles of gas turbine & jet propulsion system and their fuels.
8. Design cost effective thermodynamic systems

NOTE:

1. **Thermodynamics data hand book,** B. T. Nijaguna (to be supplied in the examination)
2. A copy of **Psychrometry chart** to be given along with answer book to the candidates (if needed)

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

TEXT BOOKS:

1. P. K. Nag, **Basic and Applied Thermodynamics**, Tata McGraw Hul Pub. 2002
2. B.K. Venkanna , **Applied Thermodynamics**, , PHI New Delhi

REFERENCE BOOKS

1. Yunus, A. Cenegal and Michael A.Boies ,**Thermodynamics, An engineering approach**, Tata Mac-Graw Hill publishing company, 2002,
2. G.J. Van Wylen and R.E. Sontang, **Fundamental of Classical Thermodynamics**, Wiley eastern.

MECHANICS OF MATERIALS

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

SEMESTER – III

Subject Code	15AU34	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Number of Tutorial Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	50	Credits	04

Course objectives:

The objectives of this course are to make students:

1. To explain the basic concepts of stress, strain
2. To explain the behavior of different engineering materials subjected to different types of loading
3. To demonstrate calculation of principal stresses using analytical and graphical methods
4. To calculate and plot shear force and bending moment diagrams for beams carrying different types of loads, and various support conditions
5. To determine deflection and slope of beams subjected to various type of loads
6. To determine the diameter of solid and hollow shafts subjected to torques
7. To demonstrate the calculation of critical loads for different type of columns using Euler's, Rankine's equations

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Stress and Strain: Introduction, Hooke's law, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.	10 Hours	L1, L2, L4
Module -2		
Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. **Cylinders:** Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.	10 Hours	L1, L2, L3, L4
Module -3		
Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin	10 Hours	

support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads. **Stress in Beams:** Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular,'I' and 'T' cross sections, Flexure Formula, Bending Stresses, Deflection of beams (Curvature). .		L1, L3, L4
Module -4		
Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections. **Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns and Secant formula for columns.	10 Hours	L1, L2, L4
Module -5		
Strain Energy: Castigliano's theorem I and II, Load deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion. **Theories of Failure:** Maximum Principal stress theory, Maximum shear stress theory.	10 Hours	L1, L4

Course outcomes:

At the end of this course student will be able to:

1. Explain the concepts of stress, strain; material properties.
2. Explain the behavior of materials under different loading conditions such as tensile, compression, shear, bending etc.
3. Calculate principal stresses using analytical and graphical methods; estimate the stresses in thick and thin cylinders.
4. Calculate bending moment (BM) and shear forces (SF) and draw the BM and SF diagrams types of beams carrying different types loads such as point load, UDL,UVL and extend the same to real life situations.
5. Calculate the deflection & slope of beams under subjected to various types of loads
6. Explain the concepts of torque and calculate the diameter of hollow and solid shafts subjected to twisting moment.
7. Stresses & angle of twist induced in to the shaft due to twisting.
8. Calculate Critical load for different types columns using Euler's, Rankine's equations & limitations of these equations and explain the applications.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. James M Gere, Barry J Goodno, **Strength of Materials**, Indian Edition, Cengage Learning, 2009.
2. S. S. Bhavikatti, **Strength of Materials,** Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.

REFERENCE BOOKS

1. S.S. Rattan, **Strength of Materials**, Tata McGraw Hill, 2009
2. K.V. Rao, G.C. Raju, **Mechanics of Materials**, First Edition, 2007
3. Egor. P. Popov, **Engineering Mechanics of Solids**, Pearson Edu. India, 2nd, Edison, 1998.
4. W.A. Nash, Shaum's Outline Series, **Strength of Materials**, Fourth Edition-2007.
5. R Subramanian, **Strength of Materials**, Oxford, 2005.

MECHANICAL MEASUREMENTS AND METROLOGY

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

SEMESTER – III

Subject Code	15AU35	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 are to make students:

1. To explain significance of mechanical measurements, elements of a generalized measuring system
2. To explain the theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure and strain
3. To define Metrology, appreciate the objectives of Metrology, and explain the importance of standards.
4. To interpret the limits specified, identify fits and explain the concept of tolerance
5. To provide the knowledge of working principle of comparators, screw and gear metrology

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Measurements, Measurement Systems and Standards of Measurement: Definition, significance of measurement, generalized measurement system, definition and concept of accuracy, precision, sensitivity, Calibration, threshold, hysteresis, repeatability, linearity, loading effect, system response, time delay, errors in measurement, classification of errors. Definition and objectives of metrology, Standard of length- International prototype meter, Imperial standard yard, Wave length standard, Subdivision of standards, line and end standard, comparison, Transfer from line standard to end standard, calibration of end bars (Numerical)	10 Hours	L1, L2, L3, L5
Module -2		
Comparators and Angular Measurements: Introduction to Comparator, Characteristics, Classification of Comparators, Sigma comparators, dial indicators, optical comparators, principles, ziess ultra optimeter, Electric and electronic comparators –principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Bevel protractor. Sine principle, use of sine bars, sine centre, angle gauges (numerical on building of angles)	10 Hours	L1, L2, L3, L6

Module -3		
Transducers, Intermediate Modifying Devices and Interferometer: Transfer efficiency, primary and secondary transducers, Mechanical, electrical, electronic transducers, advantages of each type of transducers. Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, signal transmission (hydraulic transmission, magnetic transmission, electrical transmission) Clinometers. Principle of inter-ferometry, autocollimator, optical flats. .	10 Hours	L1, L2, L3, L6
Module -4		
Measurement of Force, Torque, and Display Devices: Principle, analytical balance, platform balance proving ring, torque measurement, types of dynamometers prony brake, Hydraulic dynamometer, Eddy current dynamometer. Mechanical, digital read out devices, ultra-violet recorders, servo-recorders cathode ray oscilloscope, Oscillographs, X-Y plotters.	10 Hours	L1, L2, L3
Module -5		
System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. **Strain Measurement, Pressure Measurement and Temperature Measurement:** Strain gauge, preparation and mounting of strain gauges, gauge factor, Methods of strain measurement Principle, use of elastic members, bridge man gauge, Mc leod gauge, thermal conductivity gauge, (pirani gauge and thermocouple vacuum gauge) ionization gauge, Resistance thermometers, thermocouple, law of thermocouple, thermocouple circuits, thermocouple materials, pyrometers, optical pyrometer.	10 Hours	L1, L2, L3, L6

Course outcomes:

At the end of the course, students will be able to:

1. Explain the significance of mechanical measurements and components of a generalized measurement system.
2. Classify and explain principles of various types of transducers, modifying devices and terminating devices.
3. Explain the working principle of instruments used for measurement of Force, Torque, Pressure, Temperature, Strain and Vibration.
4. Explain the objectives of metrology and explain various standards of length such as line and end standards.
5. Demonstrate the skills of interpreting various types of limits, fits and tolerances.
6. Classify the comparators and explain their working principles.

7. Explain the usage of instruments used for the measurement of screw thread and gear parameters.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

TEXT BOOKS:

1. R.K. Jain, **Engineering Metrology** - Khanna Publishers, New Delhi.
2. D. S. Kumar, **Mechanical Measurements and Control** - Metropolitan Book Co. Pvt. Ltd, New Delhi.

REFERENCE BOOKS

1. ASTME- **Hand book of Industrial Metrology** - PHI
2. K.J. HUME, **Engineering Metrology** - Third (metric) Edition - Kalyani publishers.
3. BECKWITH, BUCK & MARAN-GONI, **Mechanical Measurements** - Narosa Publishing House.
4. DOEBELIN, **Measurement systems - Application a Design**, (4th Edition) - McGraw Hill.
5. R.C. Gupta, **Engineering Precision Metrology** - Khanna Publishers, New Delhi.

MANUFACTURING PROCESS – I
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	15AU36	Exam Marks	80
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Credits	03
IA Marks	20		

Course objectives:

The objectives of this course are to make students:

1. To define various terms associated with casting processes
2. To explain methods of construction of moulds
3. To select molding machine and molding process based on material type
4. To select appropriate joining process, type of joints
5. To appreciate the importance of non-destructive testing

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process. **Patterns:** Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns. **Binder**: Definition, Types of binder used in molding sand. **Additives**: Need, Types of additives used. Types of base sand, requirement of base sand. Molding sand mixture ingredients (base sand, binder & additives) for different sand mixtures. Method used for sand molding, such as Green sand, dry sand and skin dried moulds. **Cores:** Definition, Need, Types. Method of making cores, Binders used, core sand molding. **Gates & Risers.** Principle and types. **Fettling and cleaning of castings.** Basic steps, Casting defects, Causes, features and remedies.	10 Hours	L1, L2, L3

Module -2		
Special Moulding Process & Furnaces: **Moulding Machines** : Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger. **Process:** Study of important molding processes, No bake moulds, Flaskless moulds, Sweep mould, CO_2 mould, Shell mould, Investment mould. **Metal moulds**: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, and Thixocasting processes. **Classification of furnaces:** Constructional features & working principle of coke fired, oil fired and Gas fired pit furnace, Resistance furnace, Electric Arc Furnace, Cupola furnace.	10 Hours	L1, L2, L3
Module -3		
Welding Process: Definition, Principles, Classification, Application, Advantages & limitations of welding. **Arc Welding**: Principle, Metal Arc welding **(MAW)**, Flux Shielded Metal Arc Welding **(FSMAW)**, **Gas Welding**: Principle, Oxy – Acetylene welding, Chemical Reaction in Gas welding, Flame characteristics. Gas torch construction & working. Forward and backward welding. Inert Gas Welding **(TIG & MIG)** Submerged Arc Welding **(SAW)** and Atomic Hydrogen Welding processes. **(AHW)**	10 Hours	L1, L2, L3
Module -4		
Resistance welding: principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding. Structure of welds, Formation of different zones during welding. Heat affected zone **(HAZ).** Parameters affecting **HAZ**. Effect of carbon content on structure and properties of steel. Shrinkage in welds & Residual stresses. Concept of electrodes, Filler rod and fluxes. Welding defects – Detection causes & remedy.	10 Hours	L1, L2, L3
Module -5		
Soldering, Brazing: Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods. **Inspection Methods**: Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.	10 Hours	L1, L2, L3
Course outcomes: At the end of this course student will be able to: 1. Define various terminologies used in casting process. 2. Explain basic concepts used in construction of various moulds. 3. Analyze the working of various moulding machines. 4. Select the appropriate moulding machine and moulding process depending on the type of raw		

material required to produce the desired product.

5. Select the appropriate joining process depending on the type of joint required to produce the desired product.
6. Realize the significance of Non-Destructive Testing's (NDT's).

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

TEXT BOOKS:

1. Dr. K. Radhakrishna, **Manufacturing Process-**I, Sapna Book House, 5th Revised Edition 2009.
2. P. N. Rao, **Manufacturing & Technology: Foundry, Forming and Welding**, 2nd Ed., Tata McGraw Hill, 2003.

REFERENCE BOOKS

1. Serope Kalpakjain, Steuen. R. Sechmid, **Manufacturing Technology**, Pearson Education Asia, 5th Ed. 2006.
2. Roy A Lindberg, **Process and Materials of Manufacturing**, 4th Ed. Pearson Edu. 2006.

METALLOGRAPHY AND MATERIAL TESTING LABORATORY

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

SEMESTER – III

Subject Code	15AUL 37	IA Marks	20
Number of Lecture Hours/Week	01	Exam Marks	80
Number of Practical Hours/Week	02	Exam Hours	03
Total Number of Hours	39	Credits	02

Course objectives:

The objectives of this course are to make students:

1. To demonstrate the conduct of experiments in Metallography and Material Testing Laboratory using the principles of material science and mechanics of materials
2. To explain the working of different material testing machines
3. To conduct experiments, tabulate the data, plot graphs and make thorough analysis of results

	Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
	PART-A	
1	Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray CI, SG iron, Brass, Bronze & composites.	L1, L3
2	Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat treated samples.	L1, L3
3	To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	L1
4	Non-destructive test experiments like, a. Ultrasonic flaw detection b. Magnetic crack detection c. Dye penetration testing. To study the defects of Cast and Welded specimens	L1, L3
5	Brinell, Rockwell and Vickers's Hardness test.	L1
	PART-B	
1	Tensile, Shear and Compression tests of metallic and non metallic specimens using Universal Testing Machine	L1, L3, L4
2	Torsion Test	L1, L3, L4
3	Bending Test on metallic and nonmetallic specimens.	L1, L3, L4
4	Izod and Charpy Tests on M.S, and CI specimen.	L1, L4
5	Fatigue Test.	L1

Course outcomes:

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

1. Apply the knowledge of Material Science and Mechanics of Materials to demonstrate the conduct of experiments in Metallography and Material Testing Laboratory
2. Explain the working principle of all the laboratory equipment
3. Explain the standard test procedures
4. Plot graphs (if any) and interpret the results.
5. Explain the significance of the various tests conducted in practice, research works etc.

Scheme of Examination:

ONE question from part -A	:**25 Marks**
ONE questions from part -B	**:45 Marks**
Viva -Voice	:**10 Marks**
Total:	:**80 Marks**

FOUNDRY AND FORGING LABORATORY

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

Subject Code	15AUL 38	IA Marks	20
Number of Lecture Hours/Week	01	Exam Marks	80
Number of Practical Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	39	Credits	02

Course objectives:

The objectives of this course are to make students:

1. To apply knowledge of foundry and forging for the conduct of experiments in Foundry and Forging laboratory using standard test procedures
2. To explain various foundry and forging tools and demonstrate their usage

	Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
	PART-A	
1	**Testing of Moulding Sand and Core Sand:** Preparation of sand specimens and conduction of the following tests: a. Compression, Shear and Tensile tests on Universal Sand Testing Machine. b. Permeability test c. Core hardness & Mould hardness tests. d. Sieve Analysis to find Grain Finest number of Base Sand e. Clay content determination in Base Sand	L1, L2, L3
	PART-B	
2	**Foundry Practice:** a. Use of foundry tools and other equipments. b. Preparation of molds using two molding boxes using patterns or without patterns. (Split pattern, Match c. Preparation of one casting (Aluminum or cast iron-Demonstration only)	L1, L2, L3
	PART-C	
3	**Forging Operations:** a. Calculation of length of the raw material required to do the model. b. Preparing minimum three forged models involving upsetting, drawing and bending operations. c. Out of these three models, at least one model is to be prepared by using Power Hammer.	L1, L2, L3

Course outcomes:		
At the end of this laboratory, students will be able to: 1. Apply the basic knowledge of Foundry and Forging to demonstrate the conduct of experiments in Foundry and Forging Laboratory. 2. Explain the working principle of all the laboratory equipment and accessories/tools 3. Explain the standard test procedures 4. Plot graphs (if any) and interpret the results. 5. Explain the significance of the various tests conducted in practice, research works etc.		
Scheme of Examination:		
One question from Part – A	: 25 marks	
One question from either Part-B or Part-C	: 45 marks	
Viva-Voce	: 10 marks.	
Total	**: 80 marks.**	

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

B.E. Automobile Engineering

III SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week			Examination				Credits
				Lecture	Tutorial	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT31	Engineering Mathematics-III	Mathematics	04			03	20	80	100	4
2	15AU32	Material Science and Metallurgy	Automobile	04			03	20	80	100	4
3	15AU33	Engineering Thermodynamics	Automobile	03	02		03	20	80	100	4
4	15AU34	Mechanics of Materials	Automobile	03	02		03	20	80	100	4
5	15AU35	Mechanical Measurements and Metrology	Automobile	04			03	20	80	100	4
6	15AU36	Manufacturing Process-I	Automobile	04			03	20	80	100	3
7	15AUL37	Metallographyand Material Testing Laboratory	Automobile	01		02	03	20	80	100	2
8	15 AUL38	Foundry and Forging Laboratory	Automobile	01		02	03	20	80	100	2
TOTAL				**24**	**04**	**04**	**24**	**160**	**640**	**800**	**27**

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B.E. Automobile Engineering

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week			Examination				Credits
				Lecture	Tutorial	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT 41	Engineering Mathematics-IV	Mathematics	04			03	20	80	100	4
2	15AU42	Fluid Mechanics	Automobile	03	02		03	20	80	100	4
3	15AU43	Kinematics of Machines	Automobile	03	02		03	20	80	100	4
4	15AU44	Automotive Engines	Automobile	04			03	20	80	100	4
5	15AU45	Computer Aided Machine Drawing	Automobile	01		03	03	20	80	100	4
6	15AU46	Manufacturing Process -II	Automobile	03			03	20	80	100	3
7	15AUL47	Mechanical Measurement and Metrology Lab	Automobile	-		03	03	20	80	100	2
8	15AUL48	Machine Shop	Automobile	-		03	03	20	80	100	2
TOTAL				**18**	**04**	**09**	**24**	**160**	**640**	**800**	**27**

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ENGINEERING MATHEMATICS-IV

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

Subject Code	15MAT41	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 objective is to provide students with mathematics fundamental, necessary to formulate, solve and analyze engineering problems by making them to learn the following topics

1. Numerical methods to solve ordinary differential equations
2. Finite difference method to solve partial differential equations
3. Complex analysis
4. Sampling theory
5. Joint probability distribution and stochastic process

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
Numerical Methods : Numerical solution of ordinary differential equations of first order and first degree, Picard's method, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae). Numerical solution of simultaneous first order ordinary differential equations, Picard's method, Runge-Kutta method of fourth order.	10 Hours	L1, L4, L6
Module -2		
Numerical Methods :Numerical solution of second order ordinary differential equations, Picard's method, Runge-Kutta method and Milne's method **Special Functions:** Bessel's functions- basic properties, recurrence relations, orthogonality and generating functions. Legendre's functions - Legendre's polynomial, Rodrigue's formula, problems.	10 Hours	L1, L2, L6
Module -3		
Complex Variables: Function of a complex variable, limits, continuity, differentiability,.Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula, Residue, poles, Cauchy's Residue theorem with proof and problems.**Transformations:** Conformal transformations, discussion	10 Hours	L1, L4, L6

of transformations: = , = , = + (/) and bilinear		
Module -4		
Probability Distributions: Random variables(discrete and continuous), probability functions. Poisson distributions , geometric distribution, uniform distribution, Exponential and normal distributions, Problems. **Joint probability distribution:** Joint Probability distribution for two variables, expectation, covariance, correlation coefficient.	10 Hours	L1, L2, L3, L6
Module -5		
Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **Stochastic process:** Stochastic process, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability.	10 Hours	L1, L2, L3, L6

Course outcomes: On completion of this course, students are able to:

1. use appropriate numerical methods to solve first and second order ordinary differential equations.
2. use Bessel's and Legendre's function which often arises when a problem possesses axial and spherical symmetry, such as in quantum mechanics, electromagnetic theory, hydrodynamics and heat conduction.
3. State and prove Cauchy's theorem and its consequences including Cauchy's integral formula, compute residues and apply the residue theorem to evaluate integrals.
4. Analyze, interpret, and evaluate scientific hypotheses and theories using rigorous statistical methods .

Graduate Attributes (as per NBA):

- Knowledge. of Mathematics
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

Text Books:

1. B.V.Ramana "Higher Engineering M athematics" Tata McGraw-Hill, 2006
2. B. S. Grewal," Higher Engineering Mathematics", Khanna publishers, 42nd edition, 2013.

Reference Books:

1. N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, latest edition.
2. Kreyszig, "Advanced Engineering Mathematics " - 9th edition, Wiley, 2013
3. H. K Dass and Er.RajnishVerma ,"Higher Engineerig Mathematics", S. Chand publishing, 1st edition, 2011.

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FLUID MECHANICS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15AU42	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Number of Tutorial Hours/Week	02		
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:
The objectives of this course are to make students:

1. To define fluid properties, describe Pascal's law, Hydrostatic law, and solve static fluid problems
2. To explain Buoyancy and Stability concepts of floating objects
3. To apply Bernoulli's principle to solve fluid flow problems
4. To make dimensional analysis of fluid mechanics problems
5. To explain the concepts of laminar flow, viscous flow through pipes and plates
6. To analyze various forces acting on submerged bodies

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
PROPERTIES OF FLUIDS Introduction, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapor pressure and cavitation. **Fluid Statics** : Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid.	10 Hours	L1, L2, L3, L6
Module -2		
BUOYANCY Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of Metacentric height experimentally and theoretically. **Fluid Kinematics**: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function.	10 Hours	L1, L2, L3, L4

Module -3		
FLUID DYNAMICS Introduction, equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. **Fluid Flow Measurements:**Venturimeter, orificemeter, pitot-tube, vertical orifice, V-Notch and rectangular notches.	10 Hours	L1, L2, L4
Module -4		
DIMENSIONAL ANALYSIS Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude, types of similtudes. **Flow through pipes:** Minor losses through pipes. Darey's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL.	10 Hours	L1, L2, L4, L6
Module -5		
LAMINAR FLOW AND VISCOUS EFFECTS: Reyonold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. **Flow past immersed bodies** : Drag, Lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness. **Introduction to compressible flow** : Velocity of sound in a fluid, Mach number, Mach cone, propagation of pressure waves in a compressible fluid.	10 Hours	L1, L2, L4

Course outcomes:

On completion of this course, students are able to:

1. Define fluid properties and distinguish between types of fluids.
2. Describe Pascal's law, Hydrostatic law & their application to solve engineering static fluid problems.
3. Explain the concepts of Buoyancy and stability of floating objects.
4. Explain the kinematics of fluid like types of flows, application of continuity equations.
5. Explain the forces acting when fluid is under motion & application of Bernoulli's equation for solving flow problems.
6. Explain the different methods of measurement of flows.
7. Analyze dimensional analysis methods and its applications to engineering problems.
8. Explain and estimate the various types of losses occurring when fluid is flowing through the pipes.
9. Explain the concepts of laminar flow & viscous flow through the pipe and plates.
10. Analyze various forces acting on submerged bodies in engineering flow problems.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

Text Books:

1. Fluid Mechanics by Pijush.K.Kundu, Ira M. Cohen, ELSEVIER, 3rd Ed. 2005.
2. Fluid Mechancis by Dr. Bansal, R.K., Lakshmi Publications, 2004.

Reference Books:

1. Fluid Mechanics and hydraulics, Dr.Jagadishlal, Metropolitan Book Co-Ltd., 1997.
2. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Cimbala, TataMaGrawHill, 2006.
3. Fluid Mechanics by John F.Douglas, Janul and M.Gasiorek and john A.Swaffield, Pearson
4. Education Asia, 5th ed., 2006
5. Fluid Mechanics and Fluid Power Engineering, Kumar.D.S, Kataria and Sons., 2004

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KINEMATICS OF MACHINES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15AU43	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Number of Tutorial Hours/Week	02		
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:

The objectives of this course are to make students:

1. To define the basic terms such as kinematic chain, kinematic pair, degree of freedom etc. associated with kinematics of machinery
2. To determine the mobility of given mechanisms
3. To sketch and explain inversions of four bar mechanism, single slider crank mechanism and double slider crank mechanism
4. To determine the velocity and acceleration of links using graphical or analytical methods
5. To plot the profile of a cam using displacement diagram
6. To define gear terminology and determine the velocity ratio in different gear trains

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
INTRODUCTION, KINEMATIC CHAINS,INVERSIONS & MECHANISMS Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. Inversions of Four bar chain; Single slider crank chain and Double slider crank chain. Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight-line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.	10 Hours	L1, L2, L3, L6
Module -2		
VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS Velocity and acceleration analysis of Four Bar mechanism,	10 Hours	

slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration.Angular velocity and angular acceleration of links, velocity of rubbing.Definition, Kennedy's Theorem, Determination of linear and angular velocity using instantaneous center method		L1, L2, L3, L4, L6
Module -3		
VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS, KLEIN'S CONSTRUCTION: Analysis of velocity and acceleration of single slider crank mechanism.Analysis of four bar chain and slider crank chain using analytical expressions. (Use of complex algebra and vector algebra) Analysis of velocity and acceleration of single slider crank mechanism by Klens's construction.	10 Hours	L1, L2, L3, L4, L6
Module -4		
GEARS & GEAR TRAINS Gear terminology, Law of gearing, Characteristics of involute action, Path of contact, Arc of contact, Contact ratio of Spur, Helical, Bevel and Worm gears, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Profile Modification. Types of Gear trains, velocity ratio, Train value, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.	10Hours	L1, L2, L3, L4, L6
Module -5		
CAMS Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.	10 Hours	L1, L2, L3, L4, L6

Course outcomes:

On completion of this course, students are able to:

1. Define and explain the terms such as Link, Kinematic chain, Kinematic pair, types of pairs, degree freedom, Mechanism, Machine Mobility.
2. Sketch and explain various types of mechanisms, and their inversions.
3. Draw Velocity and Acceleration of simple mechanisms using Instantaneous centre method, Analytical and Graphical methods.
4. Explain the Gear terminology, Law of gearing, gear tooth systems
5. Determine the velocity ratio of different types of gear trains using tabular and algebraic methods
6. To draw cam profile and calculate the velocity and acceleration of cams at any given instant.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

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Question paper pattern:

The question paper will have ten questions.
Each full question consists of 16 marks.
There will be 2full questions (with a maximum of four sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. **Theory of Machines",** Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
2. **"Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

Reference Books:

1. **"Theory of Machines & Mechanisms**", J.J. Uicker, , G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. **Mechanism and Machine theory**, Ambekar, PHI

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

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AUTOMOTIVE ENGINE [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15AU44	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 are to make students:

1. To differentiate between the constructions details of spark ignition and compression ignition engines and to classify engines.
2. To explain the construction and working principle of fuel systems
3. To gain the knowledge of combustion process in SI and CI engines
4. To have the thorough knowledge of supercharging and turbo charging and apply the same to IC engines
5. To gain knowledge of cooling and lubrication systems in automotive engines

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-I		
CONSTRUCTION AND OPERATION Engine classification, Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles. Two stroke SI and CI engines – construction and working. Comparison of SI and CI engines and four stroke and two stroke engines, theoretical and actual valve timing diagrams for engines. Engine Cycles: theoretical Otto, diesel and dual cycles, Fuel-air Cycles and Actual cycle.	10 Hours	L1, L2
Module -2		
FUEL SYSTEMS Air fuel ratio requirements of SI engines, Working of a simple fixed venturi carburetor and limitations, gasoline injection system, types, Diesel fuel injection systems-inline pumps, distributor pumps, Types of Nozzles, Unit injector and common rail injection systems, Need and types of governor for diesel engines and their comparison.	10 Hours	L1, L2, L4
Module -3		
COMBUSTION IN S.I AND C.I. ENGINES Introduction to combustion in SI and CI engines and stages of combustion.Factors effecting ignition lag and flame propagation in S.I. Engines, factors effecting delay period and uncontrolled combustion in C.I. Engines. Importance of Swirl, squish and turbulence in C.I. Engines	10 Hours	L1, L3, L4, L5
Module -4		
SUPERCHARGING, TURBOCHARGING and COOLING SYSTEMS Supercharging and Turbocharging, Different methods of turbocharging, Intercooling, Turbocharger controls including, waster gate, variable geometry, Need for cooling, types of cooling systems- air and liquid	10 Hours	L4, L5, L6

cooling systems. Thermo-syphon and forced circulation and pressurized cooling systems. Properties of coolants. Fuels: In		
Module -5		
FUELS AND LUBRICANTS Fuels for S.I and C. I engines and their requirements, Fuel ratings necessity of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. Properties of lubricants.BIS standards for fuels and lubricants.	10 Hours	L1, L3, L4, L5

Course outcomes: On completion of this course, students are able to:

1. Explain the constructional details of SI and CI engines and classify engines
2. Explain the construction and working of carburetors and fuel injection pumps
3. Explain the combustion process in SI and CI engines
4. Suggest an efficient cooling system for IC engines
5. Suggest a proper lubricant to be used in an automobile used in various environmental conditions

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

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

Text Books:

1. V. Ganesan "Internal Combustion Engines" 2007, Tata McGraw Hill
2. Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 2005.

Reference Books:

1. Heisler "Advanced Engine Technology" SAE Publication
2. Edward F. Obert "Internal Combustion Engines"
3. H.N. Gupta Fundamentals of Internal Combustion Engines, PHI
4. Mathur and Sharma "Internal Combustion Engines " DhanpatRai and Sons 2002
5. John B. Heywood, "Fundamentals of Internal Combustion Engines",

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COMPUTER AIDED MACHINE DRAWING [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15AU45	IA Marks	20
Number of Lecture Hours/Week	**T-01, P-03**	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Course objectives:

The objectives of this course are to make students:

1. To acquaint with the tools of drafting and modeling software
2. To draw the solutions to sections of solids, draw orthographic views of simple machine parts using software
3. To sketch and explain various thread forms and their application
4. To calculate parameters related to riveted joints and sketch them
5. To prepare assembly drawing from the list of components
6. To create solid models and draw the sectional views of automotive systems

PART A (2D Only)

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module-I		
INTRODUCTION: Review of graphic interface of the software. Basic sketching commands and navigational commands.Starting a new drawing sheet. Sheet sizes. Naming a drawing.Drawing units, grid and snap. **Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids).True shape of sections. **Orthographic views:** Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions.Precedence of lines.	08 Hours	L1, L2, L3, L5
Module -2		
THREAD FORMS Thread terminology, forms of threads – BSW Thread, Sellers thread, ISO Metric thread, square and Acme thread. Conventional representation of threads. **Fasteners**: Hexagonal headed bolt and nut with washer (assembly), square-headed bolt and nut with washer (assembly). Types of Bolt heads, special types of nuts, locking of nuts, Studs,	08 Hours	L1, L5

set screws, grub screws.		
PART B (2D Only)		
Module -3		
KEYS, COTTER AND KNUCKLE JOINTS Types of Keys, Cotter and knuckle Joints**Riveted Joints:** lap joints- single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snaphead rivets).	08 Hours	L1, L2, L5
Module -4		
AUTOMOTIVE COMPONENTS Spark plug, IC Engine valve, Rocker arm, Cylinder liner, Stub-axle, Oldham's coupling and universal coupling (Hooks' Joint) **Couplings:** Split Muff coupling, Protected type flanged coupling, pin	08 Hours	L1, L2, L5
PART C- ASSEMBLY DRAWINGS (Part drawings should be given)		
Assembly drawing of following machine parts (3D parts to be created and assembled and then getting 2D drawing with required views, along with 3D part drawings). 1. Plummer block (Pedestal Bearing) 2. Petrol Engine piston 3. I.C. Engine connecting rod 4. Screw Jack 5. Single cylinder crank shaft 6. Machine vice	18 Hours	L1, L3, L4, L5

Course outcomes:

1. Use the Solid Edge software for drawing and solid modeling.
2. Sketch the solutions of the sections of solids, determine the inclination of the cutting plane when true shape of section of an object is given.
3. Sketch and draw the orthographic views of simple machine parts (top view, front view, side view) using first angle projection.
4. Sketch and draw the sectional views of simple machine parts.
5. Sketch and draw ISO metric threads, Square, ACME & BSW forms of threads using conventional representation.
6. Distinguish between temporary and permanent joints and sketch and draw the different types of keys.
7. Sketch and draw two views of different types of riveted joints
8. Sketch and draw two views of different automotive components, couplings and joints
9. Create solid models of different parts and assemble them and draw their sectional views using Solid Edge software.
10. Prepare assembly drawings along with their bill of material.

Graduate Attributes (as per NBA):

- Engineering Knowledge.

- Problem Analysis.
- Design / development of solutions (partly).

Text Books:

1. 'Machine Drawing' , K.R. Gopala Krishna, Subhash Publication.
2. 'A Primer on Computer Aided Machine Drawing', Published by VTU, Belgaum.
3. 'Machine Drawing', N.D.Bhat&V.M.Panchal
4. 'Automobile Engineering Drawing', R.B.Gupta, SatyaPrakashan, New Delhi

Reference Books:

1. 'A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007
2. 'Machine Drawing with Auto CAD'. GoutamPurohit&GouthamGhosh, 1st Indian print Pearson Education, 2005
3. 'Machine Drawing' , N. Siddeshwar, P. Kanniah, V.V.S. Sastri, Tata Mc GrawHill,2006

Internal assessment: 20 Marks
All the sheets should be drawn in the class using software. Sheet sizes should be A3/A4. All sheets must be submitted at the end of the class by taking printouts.

Scheme of Examination: Two questions to be set from each Part.
Student has to answer one question from each Part.

PART-A: 1x15	=	15 Marks
PART-B: 1x15	=	15 Marks
PART-C: 1x50	=	50 Marks
Total	**=**	**80 Marks**

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MANUFACTURING PROCESS -II [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15AU46	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 are:

1. To explain the nomenclature of single point cutting tool, mechanics of chip formation, tool failure criteria and to solve problems on evaluation of tool life
2. To explain the construction and working of various systems in a Lathe, Shaper, Planing and Drilling machine
3. To classify grinding and milling machines and explain their construction
4. Explain the principles of broaching

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module-I		
THEORY OF METAL CUTTING& **CUTTING TOOL MATERIAL**S Single point cutting tool nomenclature, geometry, Mechanics of Chip Formation, Types of Chips. Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems on Merchant's circle diagram analysis. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life.Tool Failure Criteria, Taylor's Tool Life equation, Problems on tool life evaluation. Desired properties and types of cutting tool materials – HSS, carbides coated carbides, ceramics. Cutting fluids - Desired properties, types and selection.Heat generation in metal cutting, factors affecting heat generation.Heat distribution in tool and workpiece and chip.Measurement of tool tip temperature.	08 Hours	L1, L2, L3
Module -2		
TURNING , SHAPING and PLANING Classification of Lathe, constructional features of Turret and Capstan Lathe. Tool Layout, Different operations on lathe, machining. . Classification of Shaping Machine, PlaningMachine, shaping and planing machines, construction and working principle of planning and shaping machine.Machining time calculation on above machining operations.	08 Hours	L1, L2, L3
Module -3		

MILLING &GRINDING MACHINES Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts.Various milling operations. **Indexing**: Simple, compound, differential and angular indexing calculations. Simple problems on simple compound indexing. **Grinding Machines:** Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Centreless,cylindrical and surface grinding). Selection of grinding wheel.Grinding process parameters. Dressing and truing of grinding wheels.	08 Hours	L1, L2, L3
Module -4		
DRILLING, BROACHING PROCESS AND FINISHING OPERATIONS **Drilling Machine:**Classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, materials. **Broaching Machine:**Principle of broaching.Details of a broach.Types of broaching machines-constructional details.Applications.Advantages and Limitations. **Finishing and other Processes:** Lapping and Honing operations – Principles, arrangement of set up and application. Super finishing process, polishing, buffing operation and application	08 Hours	L1, L2, L3
Module -5		
NON-TRADITIONAL MACHINING PROCESSES Need for nontraditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.	08 Hours	L1, L2, L3

Course outcomes:
At the end of this course student will be able to:

1. Define various terminologies used in production technology.
2. Explain basic concepts used in construction of various machine tools.
3. Analyze the various mechanisms underlying the working of various machine tools.
4. Select the appropriate machining process depending on the properties of the raw material required to produce the desired product.
5. Realize the significance of non-traditional machining.
6. Realize the significance of technological advances in the field of automating manufacturing engineering activities.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).

Question paper pattern:

The question paper will have ten questions.
Each full question consists of 16 marks.

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

Text Books:

1. Workshop Technology, HazaraChoudhry, Vol-II, Media Promoters & Publishers Pvt. Ltd. 2004
2. Production Technology, R.K.Jain, Khanna Publications, 2003.
3. Production Technology, HMT, Tata MacGraw Hill, 2001.

Reference Books:

1. Manufacturing Science, AmitabhaGhosh and Mallik, affiliated East West Press, 2003.
2. Fundamentals of Metal Machining and Machine Tools, G. Boothroyd, McGraw Hill, 2000.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15AUL 47	IA Marks	20
Number of Practical Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	39	Exam Hours	03
CREDITS – 02			

Course objectives:

The objectives of this course are to make students:

1. To identify the measuring instrument and demonstrate its usage
2. To calibrate pressure sensor, thermocouple, LVDT and load cell
3. To explain the usage of slip gauges for calibration of vernier caliper, height gauge and micrometer
4. To determine the form tolerance (cylindricity and circularity)
5. To determine thread and gear parameters using standard tests
6. To take care of measuring instruments

	Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
PART-A: MEASUREMENTS		
1	Calibration of Pressure Gauge (Bourdon tube pressure gauge)	L1, L2, L3, L5
2	Calibration of Thermocouple	L1, L2, L3, L5
3	Calibration of LVDT	L1, L2, L3, L5
4	Calibration of Load cell	L1, L2, L3, L5
5	Determination of modulus of elasticity of a mild steel specimen using Strain gauges.	L1, L2, L3, L5
6	Speed measurement-using Stroboscope	L1, L2, L3, L5
PART-B: METROLOGY		
1	Calibration of Micrometer, Vernier caliper, Height gauge using slip gauges	L1, L2, L3, L5
2	Measurements using Optical Projector / Toolmaker Microscope.	L1, L2, L3, L5
3	Measurement of Angle using Sine Center / Sine bar / bevel protractor	L1, L2, L3, L5
4	Measurement of Cylindricity and Circularity of Automobile Components	L1, L2, L3, L5
5	Measurement of Straightness and Flatness	L1, L2, L3, L5
6	Calibration of Bore gauge, inside micrometer and component measurement	L1, L2, L3, L5
7	Measurement of Screw threads parameters using Two wire or Three-wire method	L1, L2, L3, L5

8	Measurements of Surface roughness using Tally Surf/Mechanical Comparator	L1, L2, L3, L5
9	Measurement of gear tooth profile using Gear Tooth Vernier/Gear Tooth Micrometer	L1, L2, L3, L5
10	Measurement using Optical Flats	L1, L2, L3, L5

Note: Students are required to know thoroughly about the;

1. Working and usage of measuring instruments such as Vernier Caliper, Micrometer, Dial gauge and slip gauges.
2. The datum and reference surfaces such as Surface plate, V-Block, Angle plates etc.

Course outcomes:

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

1. Identify the measuring instruments, explain their parts and demonstrate its usage
2. Calibrate pressure sensor, thermocouple, LVDT, load cell.
3. Demonstrate the determination of modulus of elasticity of MS specimen experimentally using strain gauges.
4. Demonstrate the usage of slip gauges for the calibration of micrometer, vernier caliper, height gauge.
5. Determine the unknown angle using sine bars, bevel protractor
6. Demonstrate the measurement of Cylindricity and circularity of given components.
7. Measure thread parameters using three wire/two wire methods and gear parameters using gear tooth vernier.
8. Demonstrate the usage of tally surf to measure the surface rough parameters of a machined component.

Scheme of Examination:

ONE question from Measurements (part -A)	35 Marks
ONE question from Metrology (part -B)	35Marks
Viva –Voce	10 Marks
Total	**80 Marks**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

MACHINE SHOP

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

SEMESTER – IV

Subject Code	15AUL 48	IA Marks	20
Number of Practical Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	39	Exam Hours	03

CREDITS – 02

Course objectives:

The objectives of this course are to make students:

1. To apply the basic concepts/knowledge gained in the course "Manufacturing Process-II" for preparing 4 to 6 models using various machining operations on machine tools like milling, drilling, lathe, shaper and grinding
2. To have knowledge of basic setting of machines for an operation and machine tool maintenance

Laboratory Experiments:	**Revised Bloom's Taxonomy (RBT) Level**
PART-A	
Preparation of **three models** on Lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.	L1, L3, L5
PART-B	
Cutting of V- Groove/ Dovetail / Rectangular groove using a shaper. Cutting of Gear Teeth using Milling Machine.	L1, L3, L5

Course outcomes:

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

1. Apply the basic concepts/knowledge of machine tools gained through the course "Manufacturing Process-II" to prepare the models listed below.
2. Demonstrate the knowledge and the skills required with respect to the operation of machine tools, carry out various machining operations.
3. Prepare the models using the above machines, study their importance and applications.

Scheme of Examination:

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

MANAGEMENT AND ENTREPRENEURSHIP

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

SEMESTER – V

Subject Code	15AU51	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 fundamentals management functions of a manager. Also explain planning and decision making processes.
2. Explain the organizational structure, staffing and leadership process.
3. Describe the understanding of motivation and different control systems in management.
4. Explain understanding of Entrepreneurships and Entrepreneurship development process.
5. Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur.
6. Summarize the preparation of project report, need significance of report. Also to explain about industrial ownership.

Module-I	
Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as art or science, art or profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches - Modem management approaches. **Planning:** Nature, importance and purpose of planning process objectives - Types of plans (meaning only) - Decision making, Importance of planning - steps in planning & planning premises - Hierarchy of plans.	10 Hours
Module-II	
Organizing and staffing: Nature and purpose of organization, Principles of organization – Typesof organization-Departmentation Committees-Centralization V_s Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of staffing-- :Process of Selection & Recruitment (in brief). **Directing:** Meaning and nature of directing Leadership styles, Motivation, Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of coordination. **Controlling:** Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).	10 Hours
Module-III	
Entrepreneur: Meaning of Entrepreneur; Evolution of .the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging. Class.	

Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.	10 Hours
Module-IV	
Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; roleof SSI in Economic Development. Advantages of SSI, Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only). **Institutional support:** Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC SingleWindow Agency; SISI; NSIC; SIDBI; KSFC.	10 Hours
Module-V	
Preparation of project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of. Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. **Industrial ownership**: Definition and meaning of Partnership, Characteristics of Partnership, Kinds of Partners, Partnership Agreement or Partnership Deed, Registration of Partnership Firm, Rights, Duties and Liabilities of Partners, Advantages and Disadvantages of Partnership, Sole proprietorship, Features, Scope Advantages and Disadvantages of Sole Proprietorship.	10 Hours

Course outcomes:

After completion of above course, students will be able to

1. Explain management functions of a manager. Also explain planning and decision making processes.
2. Explain the organizational structure, staffing and leadership processes.
3. Describe the understanding of motivation and different control systems in management.
4. Understanding of Entrepreneurships and Entrepreneurship development process.
5. Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur.
6. Summarize the preparation of project report, need significance of report. Also to explain about industrial ownership.

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. Principles of Management – P. C. Tripathi, P.N. Reddy – Tata McGraw Hill.
2. Dynamics of Entrepreneurial Development & Management-Vasant Desai,Himalaya PublishingHouse.
3. Entrepreneurship Development – Poornima. M. Charantimath, Small Business Enterprises – PearsonEducation - 2006 (2 & 4).

Reference Books:

1. Management Fundamentals - Concepts, Application, Skill Development – RobersLusier, Thomson.
2. Entrepreneurship Development - S. S. Khanka, S. Chand & Co. New Delhi.
3. Management - Stephen Robbins, Pearson Education/PHI - 17thEdition, 2003.

DYNAMICS OF MACHINES

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

SEMESTER – V

Subject Code	15AU52	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 static and dynamic forces at various points in different types of mechanism.
2. Explain balancing of rotating masses and reciprocating masses.
3. Describe fluctuation of energy in flywheel and calculation of flywheel dimensions.
4. Describe the various types of governors and to understand method of finding controlling force.
5. Describe gyroscopic couple and to understand effect of gyroscopic couple.
6. Analyze cams for follower motions.

Module-I	
Static Force analysis: Introduction, Static equilibrium, Equilibrium of two force, three force and four force members, Members with two forces and torque, Free body diagrams, Static force analysis (graphical) of four bar mechanism and slider-crank mechanism without and without friction. **Dynamic/Inertia force analysis:** Introduction, D'Alembert's principle, Inertia force , inertia torque, dynamically equivalent systems, correction couple, line of action of inertia force in a link, inertia force analysis (graphical) of a four bar mechanism, inertia force analysis (analytical) of slider crank mechanism [(i) neglecting the mass of the connecting rod; (ii) considering the mass of the connecting rod].	10 Hours
Module-II	
Balancing of Rotating Masses Introduction, Static and dynamic balancing, balancing of single revolving mass by balancing masses in same plane and in different planes, Balancing of several masses revolving in the same plane, balancing of several masses revolving in different planes. **Balancing of Reciprocating masses** Introduction, primary balancing, secondary balancing, Inertia effect of crank and connecting rod, balancing of single cylinder engine, balancing of multi cylinder-inline engine, balancing of V - engines.	10 Hours
Module-III	
Flywheel Introduction, Turning moment diagrams, Fluctuation of Energy and speed, energy stored in a flywheel, determination of size of flywheels. **Governors** Introduction, Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, condition for stability, sensitiveness, iso-chronisms, hunting, effort and power of governor.	10 Hours

Module-IV	
Friction Types friction, law of friction, force analysis of sliding body, screw friction, screw jack, flat pivot bearing, flat collar bearing. **Belt and Chain drives** Types of belts and chains, flat belts; angular velocity, law of belting, length of open and cross belts, centrifugal tension, condition for maximum power. V-belts, ratio of tensions, chain drives, chain pits and chain length.	10 Hours
Module-V	
Gyroscope Introduction, Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on bearings, aircraft, ship, stability of two wheelers and four wheelers. **Analysis of cams** Introduction, Analysis of (i) tangent cam with roller follower (ii) Circular arc cam with flat faced follower.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Calculate static forces at various points in different types of mechanism. 2. Calculate fluctuation of energy in flywheel and dimensions of flywheel. 3. Balance rotating masses and of reciprocating masses in internal combustion engine, V engine, radial engine and to solve analytically and graphically to balance the systems. 4. Calculate gyroscopic effect on stability of vehicles, ship, aircraft etc. 5. Analyze effect of profile of cam on motion of followers.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2 full 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. Theory of Machines- Rattan S.S., Tata McGraw Hill Publishing Company Ltd 2. Theory of Machines- Sadhu Singh, Pearson Publications, New Delhi	
Reference Books: 1. Theory of Machines and Mechanisms- Joseph E. Shigley, Jr. Uicker John, McGraw Hill publications. 2. Dynamics of Machinery- A. R. Holowenko, John Wiley & sons. 3. Kinematics & Dynamics of Machinery- R L. Norton, Tata - McGraw Hill. 4. Theory of Machines- R. S. Khurmi and J. K. Gupta, S. Chand and Co. 5. Theory of Machines- P.L. Ballaney, Khanna Publishers, New Delhi	

DESIGN OF MACHINE ELEMENTS - I

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

SEMESTER – V

Subject Code	15AU53	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. Define and explain basic terms related to the design of machine elements.
2. Develop skills to design various machine elements.

Module-I

Introduction:

Designation and Mechanical properties of Engineering Materials, design considerations, basic design concept (strength consideration), Failure of brittle materials, Failure of ductile materials, factor of safety, criteria for selection of factor of safety, design of simple machine members subjected to static loading (including eccentric load) [limited to biaxial stresses (normal, shear, bending, torsional, crushing/bearing, principal stresses)].

Theories of Failure:

Maximum normal stress theory, Maximum shear stress theory, Distortionenergy theory.

10 Hours

Module-II

Stress Concentration:

Stress concentration factor, design of simple elements with stress raisers.

Impact Strength:

Introduction, Impact stresses due to axial, bending and torsional loads, effect ofinertia.

Design for fatigue strength:

Introduction, types of fluctuating stresses, fatigue and endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, endurance limit modifying factors: load, size and surface factors, Stress concentration effects; notch sensitivity, design for infinite life, combined steady and variable stress, Soderberg and Goodman relationship, stresses due to combined loading, cumulative fatigue damage – Miner's equation.

10 Hours

Module-III

Design of Simple Machine Elements:

Design of Cotter and Knuckle joints. Keys: Types of keys, Design of keys, Couplings, types of couplings, design of flange type of rigid coupling, design of Bush and Pin type of flexible couplings.

Design of Shaft:

Introduction, types of shafts, shafts subjected to combined bending and twisting, shaft design (including hollow shafts) based on strength, shaft design based on torsional rigidity, ASME code for shaft design.

10 Hours

Module-IV	
Riveted Joints: Introduction, methods of riveting, Types of rivets, rivet materials, types of rivetedjoints, failures of riveted joints, joint efficiency. **Welded Joints:** Introduction, types of welded joints, design of welded joints (butt joints, fillet welds,axially loaded unsymmetrical welded joints, eccentrically loaded welded joints).	10 Hours
Module-V	
Threaded Joints: Introduction, basic terminology of screw threads, types of screw threads, types of screw fastenings, designations of screw threads, Stresses in threaded fasteners due to static loading, Effect of initial tension, threaded joints for cylinder covers, design of eccentrically loaded bolted joints. **Power Screws:** Introduction, Types of screw threads used for power screws, Design of Power Screws, efficiency, self-locking and over hauling. Design of screw jack	10 Hours
Course outcomes: After completion of above course, students will be able to 1.Explain the importance of Standards in Design, Selection of materials as per CODES & STANDARDS. 2.Analyze the various modes of failure of machine components under different static load conditions and use appropriate theories of failures to design machine components. 3.Compute the dimensions of simple machine components. 4.Design shafts for transmission of power under various conditions. 5.Design of welded joints, riveted joints and power screws	
Question paper pattern: 1 The question paper will have ten questions. 2 Each full question consists of 16 marks. 3 There will be 2 full 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- K. Mahadevan and Balaveera Reddy, CBS Publication. 2 Design Data Hand Book- K. Lingaiah, McGraw Hill, 2nd Ed.2003.	
Text Books: 1 Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007. 2 A text book of Machine Design-R.S. Khurmi and J.K. Gupta, S.Chand& Co. 3 Mechanical Engineering Design- Joseph E shigley and Charles R. G. Budynas, McGraw hill international edition- 6 , 2009.	

Reference Books:

1. Theory and problems of Machine Design,Hall, Holowenko, Laughlin (Schaum's Outlines series), TataMcGraw Hill Publishing Company Ltd., New Delhi.
2. Machine design: Paul H. Black, McGraw-Hill International Book Company.
3. Machine design-I: J.B.K. Das, SapnaBook House, Bangalore.
4. Machine design: Robert L Norton, Prentice Hall.

AUTOMOTIVE FUELS AND COMBUSTION
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V

Subject Code	15AU54	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. Introduce understanding about available energy sources for ICE.
2. Distinguish between properties of difference fuels.
3. Explain fuel refining process.
4. Determine the A/F ratio for complete combustion.
5. Explain requirements of combustion chambers for S.I. and C.I. Engines
6. Define &differentiate between multi fuel& duel fuel engines.
7. Discuss the performance characteristics of multi fuel& duel fuel engines.

Module-I

Energy Sources:

Exhaustible sources - crude oil, Natural gas, Inexhaustible sources - Solar energy, Wind power, Tidal Power, Geo-thermal power. Energy from Bio-gas, Synthetic fuels-Fuel Cells, Hydrogen-only a brief introduction.

Liquid Fuels:

Origin of petroleum, its chemistry, normal paraffin's, iso-paraffins, olefins, naphthalene and aromatics. Refining of petroleum: Fractional distillation, Cracking, Reforming process, Thermal reforming, polymerization, alkylation, and isomerisation. Properties and tests : Specific Gravity, viscosity, flash and fire points, calorific value, rating of fuels, vapour pressure, cloud and pour point, annealing point, diesel index, carbon residue and ash content determination. — 10 Hours

Module-II

Petrol and Diesel Fuels:

Properties and rating of fuels, chemical energy of fuels, Reaction Equation, Properties of A/F mixture, combustion temp, combustion charts, Lead free gasoline's, low and ultra – low sulphur diesels, LPG, C NG, Alcohols, Biodiesels, Gaseous Fuel Injections, Dual Fueling and Controls – CNG and Gasoline, Hydrogen and Diesel, Alcohols and Diesels etc. — 10 Hours

Combustion Equations:

Combustion equation, conversion of gravimetric to volumetric analysis. Determination of theoretical minimum quantity of air for complete combustion. Determination of air fuel ratio for a given fuel. Numerical problems, flue gas analysis, gas Chromatograph.

Module-III

Combustion in S.I. Engines:

Initiation of combustion, flame velocities, effect of variables on flame propagation, normal and abnormal combustion, pre-ignition, surface ignition, detonation, theories of detonation, effects of engine variables on detonation, effects of detonation, control of detonation, features and design consideration

of combustion chambers, types of combustion chambers. **Combustion in C.I. Engines:** Various stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl, squish, tumble flow, velocities, diesel knock and its effect, methods of controlling diesel knock, features and design considerations of combustion chambers, types of combustion chambers.	10 Hours
Module-IV	
Engine testing and Performance: Performance parameters, Basic measurements, Measurements of Speed, Fuel consumption, air consumption, brake power and different types of dynamometers, frictional power measurement by willam's line method, Morse test and other methods, indicated power, blow by measurement, performance maps, heat balance and related numerical.	10 Hours
Module-V	
Dual fuel and Multi-fuel Engines: Combustion in dual fuel engines, Factor affecting combustion. Main types of gaseous fuels, Supercharge knock control & Performance of diesel fuel engines. Characteristics of multi fuel engines, Modification of fuel system, suitability of various engines as multi fuel unit, performance of multi fuel engines.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Explain available energy sources for internal combustion engine. 2. Determine A/F ratio for a given fuel. 3. Explain stages of combustion in S.I. & C.I. engines. 4. Design SI& CI engine combustion chambers. 5. Explain and differentiate between multi fuel and duel fuel engines.	
Question paper pattern: 1.The question paper will have ten questions. 2.Each full question consists of 16 marks. 3.There will be 2 full 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. I.C. Engines-Mathur& Sharma, DhanpatRai& Sons, New Delhi, 1994 2. Fuels & Combustion- S.P. Sharma & Chandra Mohan, Tata McGraw-Hill, New Delhi,1987	
Reference Books: 1. Internal Combustion Engines- Ganesan, V, Tata McGraw Hill Book Co., 1995. 2. Internal Combustion Engine Fundamentals- John B. Heywood, McGraw Hill Book, 1998. 3. Internal Combustion Engine and Air Pollution- Obert, E.F., International Text Book Publishers, 1983. 4. I.C. Engines by Maleev- CBS Publications, New Delhi.	

CAD / CAM

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

SEMESTER – V

Subject Code	15AU551	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. Describe the fundamental theory and concepts of the CAD/CAM.
2. Explain the Basic hardware structure and components used in CAD systems.
3. Develop transformations for 2D geometric modeling.
4. Describe the principles of Computer Aided Designing systems and the concepts of Geometric Modeling, solid modeling, and feature-based design modeling.
5. Explain the concepts of NC and CNC programming and machining.
6. Compare and distinguish the difference between the operation and programming of a CNC machine tool using manual programming and the operation and programming of CNC machine tool using CAM systems.
7. Apply both practices (manually and CAM) to develop the G-code program. And explain the basics of FEA and Robotics.

Module-I	
Introduction: Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment. Introduction to CAD, Introduction to CAM. Advantages and disadvantages of CAD and CAM. **Hardware for CAD:** Basic Hardware structure, Working principles, usage and types of hardware for CAD – Input devices, output devices, memory, CPU, hardcopy and storage devices.	8 Hours
Module-II	
Computer graphics: Software configuration of a graphic system, function of graphics package, construction of geometry, wire frame and solid modeling, Geometry transformation – two dimensional and three dimensional transformation, translation, scaling, reflection, rotation, CAD/CAM integration. Desirable modeling facilities. Introduction to exchange of modeling data- Basic features of IGES, STEP, DXF, and DMIS **Introduction to Finite element analysis:** Introduction, basic concepts, discretization, element types, nodes and degrees of freedom mesh generation, constraints, loads, preprocessing, and application to static analysis.	8 Hours
Module-III	
Numerical Control (NC) and CNC machine tools: Basic components of an NC Systems , NC procedure , NC co-ordinate systems , open loop & closed loop system (position controlled NC) NC motion control systems, application of NC. Advantage & limitations of NC. Functions	8 Hours

of CNC, CNC machining centers, CNC turning centers, high speed CNC machine tools.	
Module-IV	
NC, CNC, DNC Technologies: NC, CNC, DNC, modes, NC elements, advantages and limitations of NC, CNC. Functions of computer in DNC **CNC tooling:** Turning tool geometry, milling tooling system, tool presetting, ATC, work holding. **CAM Programming:** Overview of different CNC machining centers, CNC turning centers, highspeed machine tools	8 Hours
Module-V	
CNC Programming: Part program fundamentals-steps involved in development of a part program.Manual part programming, milling, turning, turning center programming. **Introduction to Robotics:** Introduction, robot configuration, robot motion, programming ofrobots, end effectors work cell, control and interlock, robot sensor, robot applications	8 Hours
Course outcome: After completion of above course, students will be able to 1. Describe the fundamental theory and concepts of the CAD/CAM. Explain the Basic hardware structure and components used in CAD systems. 2. Compare the different types of modeling techniques and explain the central role solid models. 3. Describe the principles of Computer Aided Designing systems and the concepts of Geometric Modeling, solid modeling, and feature-based design modeling. 4. Explain the basic concepts of NC and CNC programming and machining. 5. Compare and distinguish the difference between the operation and programming of a CNC machine tool using manual programming and the operation and programming of CNC machine tool using CAM systems. 6. Apply both practices (manually and CAM) to develop the G-code program, and explain the basics of FEA and Robotics.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2 full 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. CAD/CAM Principles and Application- P.N. Rao, Tata McGraw Hill. 2. CAD/CAM- Groover, Tata McGraw Hill, New Delhi	
Reference Books: 1. Introduction to the Design and Analysis of Algorithms - S.E. Goodman, S.T. Headetmiemi,	

McGraw Hill Book Company – 1988.
2. Principles of Interactive Computer Graphics-Newman and Sproull, Tata McGraw Hill, 1995.
3. NC Machine Programming and Software Design-Chno-H wachang, Michel. A. Melkanoff, Prentice Hall, 1989.
4. Numerical control and CAM- Pressman RS and Williams JE, John Wiley.
5. CAD-CAM- Chris McMahon & Jimmie Browne – Pearson Education Asia 2001.
6. CAD/CAM – Ibrahim Zeid, Tat McGraw Hill, 1999.
7. Computer Aided Manufacturing- P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999.
8. Introduction to FEM- T Chandra patta Ashok D Bebgundu.

VEHICLE TRANSPORT MANAGEMENT

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

SEMESTER – V

Subject Code	15AU552	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. Introduce infrastructure required for Fleetoperation and maintenance.
2. Understand organizational structure and importance and methods of route planning.
3. Analyze different methods of fare collection systems.
4. Calculate fleet operating costs.
5. Explain different methods of accident prevention.

Module-I	
Introduction: Historical background, the growth of a network, trams, trolley buses, buses, private cars, subsidies. Motor vehicle act 1988. **The Infrastructure:** Road, Highway network, traffic control, Bus priorities, pedestrianization, out town shopping centers, Bus-stops, shelters, Bus stations-drive through type, head on type, facilities for passengers, bus garages, requirement, layout of premises, size, function, ,location, design, equipment, use of machinery, garage organization, large scale overhaul conveyance of staff, requirement of facilities at depot., legal provisions for depot. Layouts. **Maintenance:** Preventive, breakdown, overhauling - major, minor, repair schedules & workshop, facilities,documentation, analysis & corrective maintenance schedules.	8 Hours
Module-II	
Organization and Management: Forms of ownership, municipal undertaking, company undertaking, traffic, secretarial and engineering department, management, principle of transport, - internal organization-centralized control, de-centralized control, staff administration: industrial relation, administration, recruitment and training, drivers and conductors duties, training of drivers and conductors, factors affecting punctuality, welfare, health and safety. **Route planning:** Source of traffic, town planning, turning points, stopping places, shelters, survey of route, preliminary schedule test runs, elimination of hazards, factors affecting frequency, direction of traffic flow, community of interest, estimating, traffic volume, probable weekday travelers, passengers during various periods of the day, estimated number of passengers, estimated traffic, possibility of single verses double deck and frequency	8 Hours

Module-III	
Fare collections & Fare structure Need, Principles of collection, tickets, the way bill, stage by stage, bell punch system, bell-graphic system, reduced ticket stocks will brew system, mechanical ticket machines, T.I.M and straight machines, Vero meter, one-man operation, two stream boarding, pre paid tickets, lensonparason coach tickets exchanges, the fare box, electronic ticket machines, box system personal and common stock flat fare platform control. Fare structure: Basis of fares, historical background, effects of competition and control, calculating average zone system, concession fares, straight and tapered scale elastic and inelastic demand co-ordination of fares concessions fares changes for workman, standard layout of fare table, anomalies double booking inter availability through booking and summation, private hire charges.	8 Hours
Module-IV	
Operating cost and types of vehicles: Classification of costs, average speed, running costs, supplementary costs, depreciation obsolescence, life of vehicles, sinking fund, factor affecting cost per vehicles mile incidence of wages and overheads, 100 seats miles basis, average seating capacity, vehicles size and spread over, types of vehicle economic considerations authorization of trolley, bus services, statuary for hire car. **Public relations divisions:** Dissemination of information, maintaining goodwill- handling complaints, traffic advisory committees- local contractors co-operation with the press news and articles- facilities for visitors- forms of publicity - importance of quality - inter departmental liaison advertisements, sings, notice and directions general appearance of premises, specialized publicity.	8 Hours
Module-V	
Prevention of accidents: Emphasis of safe driving, annual awards, bonus encouragement, vehicle design, platform layout, location of stops, scheduled speed, route hazards, records, elimination of accident prone drivers. **Timing, Bus working and Schedules:** Time table layout, uses of flat graph method of presentation, preparation of vehicle and crew schedule preparation of the duty roster, co-operation with employers, use of the vehicle running numbering determination of vehicle efficiency checking efficiency of crew, duty arrangements. **Vehicle design:** Buses & coaches, types & capacities, basic features, entrances & exits, comfort & capacity, steps & staircases, miscellaneous arrangements & fitments, articulated buses, standardization. The future: a projection from the past, future demand, environmental and social issues, the energy situation, new technology, hybrid ,battery/trolley bus, other types of hybrid, lead acid battery bus, advanced battery bus.	8 Hours

Course outcomes:

After completion of above course, students will be able to

1. Determine infrastructure required for Fleet maintenance.
2. Plan routes for fleet.
3. Analyze fare collection system.
4. Calculate fleet operating costs.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full 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. Bus operation- L .D .Kitchen, Iliffe&Sons , London.
2. Bus & coach operation - Rex W. Faulks, Butterworth Version Of 1987, London.

Reference Books:

1. Compendium of transport terms - CIRT, Pune.
2. M.V. Act 1988 - Central Law Agency, Allahabad.
3. The elements of transportation - R.J. Eaton.
4. Goods vehicle operation - C.S. Dubbar.
3. Road transport law - L.D. Kitchen,Iliffe&Sons , London.

AUTOMOTIVE AIR CONDITIONING AND REFRIGERATION

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

SEMESTER – V

Subject Code	15AU553	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. Introduce basic concepts of air conditioning and refrigeration.
2. Analyze various gas cycles for refrigeration.
3. Describe layouts and construction of central and unitary air conditioning system.
4. Analyze refrigeration, heating and air conditioning load calculations and effect of air conditioning on engine performance.
5. Describe air distribution, air routing and temperature control.
6. Detained information about basic concepts of air conditioning servicing

Module-I	
Air conditioning Fundamentals: Basic air conditioning system,- Air conditioning principles, Air-conditioning types, temperature and pressure fundamentals, types of compressors and refrigerants. **Gas cycle refrigeration:** Introduction, reverse cornot cycle, bellcoleman cycle, advantages and disadvantages of gas refrigeration system. Analysis of gas refrigeration, relatednumerical.	8 Hours
Module-II	
Air conditioning systems: Classification, layouts, central /unitary air conditioning systems, components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems, Automotive heaters, Types, Heater Systems, Air conditioning protection, Engine protection.	8 Hours
Module-III	
Load Analysis: Outside & inside design consideration, factors forming the load on refrigeration & air conditioning systems, cooling & heating load calculations, load calculations for automobiles, effect of air conditioning load on engine performance.	8 Hours
Module-IV	
Air Distribution Systems: Distribution duct system, sizing, supply /return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations. **Air Routing & Temperature Control:** Objectives, evaporator air flow, through the re-circulating unit, automatic temperature control, duct system, controlling flow, vacuum reserve, testing the air control of air handling systems.	8 Hours

Module-V	
Air conditioning service: Air conditioner maintenance & service- causes of air conditioner failure, leak testing guide, discharging the system, Evacuating the system, charging the system, servicing heater system, removing & replacing components, trouble shooting of air conditioning system, compressor service, methods of dehydration, charging & testing. **Air Conditioning Control** Common control such as thermostats, humidistat, control dampers, pressure cut outs, relays.	8 Hours

Course outcomes:

After completion of above course, students will be able to

1. Explain basic concepts of air conditioning and refrigeration.
2. Analyze various gas cycles for refrigeration.
3. To design required layouts of central and unitary air conditioning system.
4. Analyze refrigeration, heating and air conditioning load and effect of air conditioning on engine performance.
5. Design air distribution, air routing and temperature control in air conditioning system.
6. Explain basic concepts of air conditioning servicing.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full 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 Heating & Air Conditioning- Mark Schnubel, Thomson Delmar Learning, 3rd edition, NY.
2. Automotive Air Conditioning- William H. Crouse & Donald L. Anglin,McGrawHill, Inc., 1990.
3. Refrigeration and Air conditioning- C. P Arora, TMH.

Reference Books:

1. Automotive Air-Conditioning-Boyace H. Dwiggins.
2. HVAC Fundamentals- SamSugarman, Fairmont Press- IS BN0-88173-489-6.
3. Automotive Air Conditioning- Paul Weisler, Reston PublishingCo.Inc.1990.
4. Automotive Air Conditioning- Paul Lung, C.B, S. Publisher & Distributor, Delhi.
5. Automotive Air Conditioning- MacDonald K. L, The odoreAudel series, 1978.

HYDRAULICS AND PNEUMATICS

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

SEMESTER – V

Subject Code	15AU554	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. Introduce basics of Hydraulics and pneumatics.
2. Describe Various components of hydraulic system and maintenance of hydraulic system
3. Design hydraulic system.
4. Describe layout and details of pneumatic systems.

Module-I	
Introduction to Hydraulic Power: Pascal's law, The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, variable displacement pumps. **Hydraulic Actuators and Motors:** Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors and piston motors.	8 Hours
Module-II	
Control Components in Hydraulic Systems: Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves. **Maintenance of Hydraulic systems:** Hydraulic oils – Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.	8 Hours
Module-III	
Hydraulic Circuit Design and Analysis: Control of single and Double – acting Hydraulic cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.	8 Hours
Module-IV	
Pneumatic controls: Choice of working medium, characteristics of compressed air. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals. Rod – less cylinders – types, working advantages. Rotary cylinder types construction. **Directional Control valves**	8 Hours

Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. **Simple Pneumatic Control** Direct and indirect actuation pneumatic cylinders. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve.	
Module-V	
Multi-cylinder applications: Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves). **Electro-Pneumatic control:** Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications. **Compressed air:** Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout.	8 Hours
Course outcomes: After completion of above course, students will be able to 1. Describe Various components of hydraulic system and maintenance of hydraulic system. 2. Design hydraulic system. 3. Describe layout and details of pneumatic systems.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2 full 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. Fluid Power with applications- Anthony Esposito, Fifth edition Pearson education, Inc. 2000. 2. Pneumatics and Hydraulics- Andrew Parr,Jaico Publishing Co. 2000.	
Reference Books: 1. Oil Hydraulic Systems – Principles and Maintenance- S.R. 2002 Majumdar, Tata McGraw Hill publishing company Ltd. 2001. 2. Pneumatic systems - S. R. Majumdar, Tata McGraw Hill publishing Co., 1995. 3. Industrial Hydraulics -Pippenger Hicks, McGraw Hill, New York.	

AUTOMOTIVE ENGINE COMPONENTS LAB

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

SEMESTER – V

Subject Code	15AUL57	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. To write technical specifications of different types of engines
2. To dismantle and assemble the S. I and C.I Engines and to inspect the engine parts for wear, cracks, etc.
3. Perform vacuum and compression test on diesel and Petrol engine.
4. To dismantle and assemble different units of fuel system, cooling system, lubricating system.

Laboratory Experiments:

PART-A

1. Study of Hand tools- sketching , material and their application
2. Writing Technical specifications and description of all types of engines
3. Dismantling and assembly of engines (SI and CI), identification of major components, inspection of different components for wear, cracks, measurement and comparison of dimensions of major components with standard
4. Compression and vaccum test on diesel and petrol engines

PART-B

Dismantling & assembly and inspection of :

1. Carburetors, Fuel injection pumps, Injectors, Fuel filters, Fuel pumps
2. CRDI system
3. Turbo-chargers
4. Cooling systems and Lubricating systems.

Identification of location of above components in a vehicle and note their functions along with the brand names.

Course outcomes:

After completing all above experiments students will be able to:

1. write technical specifications of different types of engines.
2. Dismantle and assemble the S. I and C.I Engines and to inspect the engine parts for wear, cracks, etc.
3. Perform vaccum and compression test on diesel and Petrol engine.
4. To dismantle and assemble different units of fuel system, cooling system, lubricating system.

Scheme of Examination:

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

FLUID MECHANICS AND FUELTESTING LAB

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

SEMESTER – V

Subject Code	15AUL58	IA Marks	20
Number of Lecture Hours/Week	01I + 02P	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	02		

Course objectives:

The objectives of this course is to

1. To apply the basic concepts/knowledge gained in Fluid mechanics and Fuel testing for verifying basic laws governing flow of fluids and to determine various properties of fuels used for automotive internal combustion engines.

Laboratory Experiments:

PART-A

Fluid Mechanics

1. Determination of coefficient of discharge of venturi meter and orifice meter.
2. Determination of major and minor losses in pipe flow (sudden enlargement, contraction, bend, entry and exit).
3. Performance testing of fluid pumps(Centrifugal, reciprocating and gear pumps).
4. Performance testing of air blowers.

PART-B

Fuel Testing

1. Determination of flash and fire point of fuels.
2. Determination of calorific value of solid, liquid and gaseous fuel.
3. Determination of viscosity of oils using redwood, saybolt and Torsion viscometer.
4. Determination of carbon residue and moisture content in a fuel.
5. Determination of cloud and pour point of oils.

Course outcomes:

After completing all above experiments, students will be able to:

1. Determine coefficient of discharge of venture meter and orifice meter.
2. Determine major and minor losses in flow through pipes.
3. Investigate performance characteristics of various fluid pumps.
4. Determine flash point, fire point, calorific value, viscosity, cloud point, moisture content of fuel and lubricants.

Scheme of Examination:

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

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

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS

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

SEMESTER – VII

Subject Code	15AU71	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: At the end of the course the student will be able to -

1. Explain the construction of battery used in automotive vehicles.
2. Describe the construction and working of D.C. generator, alternator, cranking motor, ignition systems along with trouble shooting.
3. Discuss the faults arising in automotive wiring and lighting system.
4. Explain various chassis electrical systems.
5. Describe transducers and sensors.
6. Understand various aspects of electrical and Hybrid vehicles.

Module-I	
Introduction: Earth return and insulated systems, 6volts and 12 volts system, fusing of circuits, low and high voltage automobile cables, cable specifications, diagram of typical wiring system, and symbols used in automobile electrical systems. **Storage Battery:** Principle of lead acid cells, plates and their characteristics containers and separators, electrolyte and their preparation, effect of temperature on specific gravity of electrolyte, battery capacity and efficiency, battery rating, battery testing, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries,different types of batteries and their principles like alkaline, lithium and zinc air etc.,	10 Hours
Module-II	
Generator/ Alternator: Principle of generation of direct current, generator details, shunt dynamos, armature reaction, action of three brush generator and battery in parallel, setting of third brush, voltage and current regulators, cutout relay - construction, working and adjustment. Construction and working of alternator and output control. **Starter Motor & Drives:** Battery motor starting system, condition at starting, behavior of starter during starting, series motor and its characteristics, considerations affecting size of motor, types of drives, starting circuit.	10 Hours
Module-III	
Ignition systems: Ignition fundamentals, working of battery and magneto ignition systems, comparison of battery and magneto ignition system, advantages and disadvantages of conventional ignition systems, Types of solid state ignition systems, components, construction and working, high energy ignition distributors, Electronic spark timing	10 Hours

control. **Lighting system and Dashboard Instruments.** Principle of automobile illumination, head lamp mounting and construction, sealed beam auxiliary lightings, horn, windscreen-wipers, signaling devices, electrical fuel pump, fuel, oil and temperature gauge, speedometer, odometer, etc. (Dash board instruments)	
Module-IV	
Engine management Systems: Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation. Complete vehicle control systems, Artificial intelligence and engine management. Hybrid vehicles and fuel cells. **Chassis Electrical systems:** Antilock brakes (ABS), Active suspension, Traction control, Electronic control of automatic transmission, other chassis electrical systems, Central locking, Air bags and seat belt tensioners, seat heaters.	10 Hours
Module-V	
Electrical and hybrid vehicles Components of an EV, EV batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEV drive train components, advantages of HV. **Transduces and sensors** Definition and classification, principle of working and application of various light sensors, proximity sensors and Hall effect sensors.	10 Hours

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

1. Explain the construction of battery used in automotive vehicles.
2. Describe the construction and working of cranking motor, D. C. generator, alternator, ignition systems along with trouble shooting.
3. Discuss the faults arising in automotive wiring and lighting system.
4. Explain various chassis electrical systems.
5. Describe transducers and sensors.
6. Explain various aspects of electrical and Hybrid vehicles.

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. Automobile Electrical and Electronic systems - Tom Denton,SAE publication, 2000.
2. Automotive Electrical Equipment - P.M. Kohli,Tata McGraw Hill, New Delhi.

3. Alternative Fuels- S .S. Thipse, JAICO Publishing House, New Delhi.
4. Mechatronics – W.Bolton, Longman, 2Ed, Pearson publications, 2007.

Reference Books:

1. Advanced Engine Technology - Heinz Heisler,SAE Publications, 1995.
2. Automotive Electronic Systems - Ulrich Adler, Robert Bosch, GMBH, 1995.
3 Bosch Technical Instruction Booklets.
4. Automobile Electrical Equipment - A.P. Young & Griffiths, ELBS &NewnesButterworths, London.

AUTOMOTIVE ENGINE COMPONENTS DESIGN AND AUXILIARY SYSTEMS

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

SEMESTER – VII

Subject Code	15AU72	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: At the end of the course the student will be able to –

1. Calculate major dimensions of engine components like cylinder, piston, connecting rod, crankshaft, valve and valve operating mechanisms.
2. Analyze working of two stroke engine.
3. Select suitable scavenging process for two stroke engine.
4. Select suitable lubricant and lubrication system for given engine.
5. Calculateamount coolant required and select suitable cooling system for given engine. Explain need for supercharger and modifications required in engine for supercharging.

Module-I	
<u>Design of major dimensions of</u> **Cylinder heads & Cylinder Block** Cylinder heads, Gaskets, cylinder wear, water jacket, Cylinder liners, and valve seats. Production of engine block – casting, cleaning, treatment, machining operations and transfer machines **Piston, piston rings and piston pin** Piston Temperatures, piston slap, compensation of thermal expansion in pistons. Piston Rings, forms of gap, stresses in piston rings, ring collapse, heat treatment, piston ring selection, shape. Piston pin, locking of piston pins, length of piston.	10 Hours
Module-II	
<u>Design of major dimensions of</u> **Connecting rod** Length of rod, Cross section, Buckling, Drilled connecting rods, piston pin bearing, offset connecting rods, effects of whipping, bearing materials and lubrication. **Crank shaft** Balance weights, local balance, Crankshaft proportions, oil holes drilled in crank shafts, balancing, vibration dampers, firing order, bearings and lubrication Types of crank shafts, design of centre crank shaft, moments on crank shafts, centre crank shaft at tdc, centre crank shaft at angle of maximum torque. Design of side crankshaft (over hang), side crank shaft at tdc, side crank shaft at angle of maximum torque.	10 Hours
Module-III	
Valve and valve mechanism No. of Valves per cylinder, Angle of seat, Operating Conditions, operating temperatures, valve cooling, Sodium cooled valves, Valve rotators, valve seats, valve guides, , valve springs, valve clearance, valve timing, OHV, OHC, dual	10 Hours

valves, types of valve operating mechanisms. Valve train component details, Camshaft,-drives of cams, cam types, tappets,-automatic zero clearance tappets, push rods, rocker arms & rocker Shaft. **Design of major dimensions** of valve and valve operating mechanisms. **Two stroke engines** Principles and working of two stroke engine (SI & CI), Port timing diagrams. Types - Three port engine, Separate pumps or blowers, Symmetrical & unsymmetrical timing, Cross flow, loop flow &uniflow type Scavenging systems. Scavenging Process – Pre blow down, Blow down, Scavenging, Additional Charging. Theoretical Scavenging processes, Scavenging parameters, Comparison of Different Scavenging Systems; port design, scavenging pumps.	
Module-IV	
Manifolds and Mixture Distribution Intake system components, Discharge coefficient, Pressure drop, Air filter, Intake manifold, Connecting pipe, Exhaust system components, Exhaust manifold and exhaust pipe, Spark arresters, Waste heat recovery, Exhaust mufflers, Type of mufflers, exhaust manifold expansion. **Cooling System** Necessity, variation of gas temperature, Areas of heat flow, heat transfer, piston and cylinder temperature, Heat rejected to coolant, quantity of water required, air cooling, water cooling, thermodynamics of forced circulation, thermostats, pressurized water cooling, regenerative cooling, comparison of air and water cooling, radiators – types, cooling fan – power requirement, antifreeze solution, types of coolant	10 Hours
Module-V	
Lubrication System Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, additives and lubricity improvers, concept of adiabatic engines, oil filters, pumps, and crankcase ventilation – types. **Supercharging and Turbocharging** Purpose, thermodynamic cycle, effect on the performance, turbo charging, limits of supercharging for petrol and diesel engines. Modifications of an engine for super charging - methods of super charging – super charging and turbo charging of two stroke and four stroke engines.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Calculate major dimensions of engine components like cylinder, piston, connecting rod, crankshaft, valve and valve operating mechanisms. 2. Analyze working of two stroke engine. 3. Select suitable scavenging process for two stroke engine. 4. Select suitable lubricant and lubrication system for given engine. 5. Calculate amount coolant required and select suitable cooling system for given engine. 6. Explain need for supercharger and modifications required in engine for supercharging.	
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. High Speed Engines - P.M.Heldt, Oxford & IBH, 1965
2. Machine design exercises - S. N. Trikha, Khanna publications, Delhi

Reference Books:

1. Auto Design – R.B. Gupta, SatyaPrakash, New Delhi 1999.
2. A course in I.C. Engine –Mathur& Sharma , DhanpatRai& Sons, Delhi, 1994.
3. Internal Combustion Engines-V.Ganesan, Tata McGraw Hill, Delhi, 2002.
4. Automobile Engineering Vol. II - Kirpal Singh, Standard publications, New Delhi, 2005
5. Modern Petrol Engine - A.W. Judge, B.I. Publications. 1983
6. Fundamentals of I. C. Engines - J.B.Heywood, McGraw Hill International Edition.
7. Machine design - P.C. Sharma & D.K. Aggarwal, S.K.Kataria& sons, Delhi.
8. I. C. Engine - Maleev&Litchy, McGraw Hill.

FINITE ELEMENT MODELING AND ANALYSIS
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

Subject Code	15AU73	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: At the end of the course the student will be able to

1. Describe the fundamentals of structural mechanics and finite element method.
2. Develop element stiffness matrix for different elements using various methods.
3. Illustrate different methods of deriving shape functions for various elements.
4. Analyze one dimensional structural and thermal problem.

Module-I	
Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. Boundary conditions, Matrix algebra, Gaussian elimination method, Eigen values and Eigen vectors, **Basic Procedure**: Euler - Lagrange equation for bar, beam (cantilever /simply supported fixed) Principle of virtual work, principle of minimumpotential energy, Raleigh's Ritz method.	10 Hours
Module-II	
Basic Procedure: Direct approach for stiffness matrix formulation of bar element. Galerkin's method. **Discretizationof Structure:** Steps in FEM**,** discritization process, element types-one, two, three and axisymmetric elements, Interpolation polynomials, shape functions: for one dimensional linear element, quadratic and cubic elements, shape functions in natural coordinates, Convergence requirements, selection of the order of the interpolation polynomial, Pascal triangle. Application and limitations of FEM.	10 Hours
Module-III	
Solution of 1D Bar: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique **Trusses:** Stiffness matrix of Truss element. Numerical problems.	10 Hours
Module-IV	
Higher order and Iso-parametric Elements: Lagrangian interpolation, Higher order one dimensional elements- quadratic, cubic elements and their shape functions, properties of shape functions, shape functions for 2D quadratic triangular element in natural coordinates, 2D quadrilateral element shape functions- linear, quadratic, shape function of beam	10 Hours

element. Hermiteshape function of beam element.	
Module-V	
Beams: Hermite shape functions for beam element, Derivation of stiffnessmatrix. Numerical problems of beams carrying concentrated, UDL andlinearly varying loads. **Heat Transfer**: Steady state heat transfer, 1D heat conduction governingequations. Functional approach for heat conduction. Galerkin's approach forheat conduction. 1D heat transfer in thin fins.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Describe the fundamentals of structural mechanics and finite element method. 2. Develop element stiffness matrix for different elements using various methods. 3. Illustrate different methods of deriving shape functions for various elements. 4. Analyze one dimensional structural and thermal problem.	
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. Finite Elements in Engineering - T.R.Chandrupatla, A.D Belegunde,3rd Ed PHI. 2. Finite Element Method in Engineering- S.S. Rao, 4th Edition,Elsevier, 2006.	
Reference Books: 1. Finite Element Methods for Engineers -U.S. Dixit, CengageLearning, 2009 2. Concepts and applications of Finite Element Analysis -R.D. Cook, D. S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009 3. Finite Element Methods - Daryl. L. Logon, Thomson Learning 3rdedition, 2001. 4. Finite Element Method - J.N.Reddy, McGraw -Hill InternationalEdition.	

EARTH MOVING EQUIPMENT & TRACTORS

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

SEMESTER – VII

Subject Code	15AU741	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: At the end of the course the student will be able to

1. Gain the knowledge about various basic operations and applications of earth moving equipment.
2. Acquire the knowledge of under carriage, hydraulics, steering of tractors.
3. Get the complete information about the earth moving equipment
4. Select suitable machine depending on type of land, haul distance, climate, etc.

Module-I	
Equipment and operation: Different types, working principles and applications of bull Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments.	08 Hours
Module-II	
Engine, under carriage and Suspension systems: All systems of engine and special features like Automatic injection timer, turbochargers, after coolers etc.,Tyre and tracked vehicles, advantages and disadvantages under carriage components like, tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. Rubber spring suspension and air spring suspension.	08 Hours
Module-III	
Transmissions and Final drives: Basic types of transmissions, auxiliary transmission, compound transmission, twin triple countershaft, transmissions and planetary, transmission, constructional and working principles, hydro shift automatic Transmission and retarders. FINAL DRIVES: types of reductions like, single reduction, double reduction final drives and planetary final drives PTO shaft.	08 Hours
Module-IV	
Hydraulics: Basic components of hydraulic systems like pumps (types of pumps), control valves like flow control valves, directional control valves and pressure control valves, hydraulic motors and hydraulic cylinders. Depth & draft control systems.	08 Hours
Module-V	
Criterions for selection of equipment: Selection of machines based on type of soil, haul distance, weather condition, calculation Of Operating Capacity and calculation of productivity of a bull dozer **Earth Moving Equipment Maintenance & Safety:** Types of maintenance schedules, purpose and advantages, organization set ups, documentation. Safety methods for earth moving equipment.	08 Hours

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

1. Gain the knowledge about various basic operations and applications of earth moving equipment.
2. Acquire the knowledge of under carriage, hydraulics, steering of tractors.
3. Get the complete information about the earth moving equipment
4. Select suitable machine depending on type of land, haul distance, climate, etc.

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. Diesel equipment- volume I and II by Erich J.schulz
2. Construction equipment and its management - S.C. Sharma

Reference Books:

1. Farm machinery and mechanism - Donald R. hunt and L. W. Garner
2. Theory of ground vehicles - by J.Y.Wong john Wiley and sons
3. Moving the earth - Herbert Nicholas
4. On and with the earth -Jagman Singh, W.Newman and Co. culkatta

COMPUTER INTEGRATED MANUFACTURING

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

SEMESTER – VII

Subject Code	15AU742	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: At the end of the course the student will be able to

1. Explain need for computer integrated manufacturing.
2. Calculate WIP, TIP ratios using mathematical modeling.
3. Explain various drives and mechanisms used in CIM.
4. AnalyzeAutomated Flow line & Line balancing.
5. Analyze AGV's.
6. Explain steps involved in development of part programming for milling and turning processes.
7. Programme the robots for given application.

Module-I	
Computer Integrated Manufacturing Systems : Introduction, Automation definition, Types of automation, CIM, processing in manufacturing, Production concepts, Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work-in-process, WIP ratio, TIP ratio, Problems using mathematical model equations. **High Volume Production System:** Introduction Automated flow line-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Rachet& Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality.	08 Hours
Module-II	
Analysis of Automated Flow line & Line Balancing : General terminology and analysis, Analysis of Transfer Line with Out storage-upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with example problem, Partial automation-with numerical problem example, flow lines with more than two stage, Manual Assembly lines balancing numerical problems.	08 Hours
Module-III	
Automated Assembly Systems: Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement analysis of Multistation Assembly machine analysis of single station assembly.	08 Hours

Automated Guided Vehicle System: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's withnumerical problems and application.	
Module-IV	
Minimum rational work element: Work station process time, Cycle time, precedence constraints. Precedence diagram, balance delay methods of line balancing-largest candidate rule, Kilbridge and Westers method, Ranked positional weight method, Numerical problems covering above methods and computerized line balancing. **Computerized Manufacturing Planning system :** Introduction, Computer Aided process planning, Retrieval types of process planning , Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning.	08 Hours
Module-V	
CNC Machining Centers: Introduction to CNC, elements of CNC, CNC machining centers, part programming, and fundamental steps involved in development of part programming for milling and turning. **Robotics:** Introduction to Robot configuration, Robot motion, and programming of Robots end effectors, Robot sensors and Robot applications.	08 Hours
Course outcomes: After completion of above course, students will be able to 1. Explain need for computer integrated manufacturing. 2. Calculate WIP, TIP ratios using mathematical modeling. 3. Explain various drives and mechanisms used in CIM. 4. Analyze Automated Flow line & Line balancing. 5. Analyze AGV's. 6. Explain steps involved in development of part programming for milling and turning processes. 7. Programme the robots for given application.	
Question paper pattern: The question paper will have ten questions. 1. Each full question consists of 16 marks. 2. There will be 2full questions (with a maximum of four sub questions) from each module. 3. Each full question will have sub questions covering all the topics under a module. 4. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. Automation, Production system & Computer Integrated manufacturing-M. P. Grover PersonIndia, 2007, 2nd edition. 2. Principles of Computer Integrated Manufacturing-S. Kant Vajpayee, Prentice Hall India	
Reference Books: 1. Computer Integrated Manufacturing- J.A.Rehg& Henry.W. Kraebber. 2. CAD/CAM -Zeid, Tata McGraw Hill. 3. Introduction to Robotics -Mechanica and Control, Craig, J. J., 2nd Edition, Addison-Welsey,	

1989.
4. Fundamentals of Robotics - Analysis and Control, Schilling R. J., PHI, 2006.

TRIBOLOGY

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

SEMESTER – VII

Subject Code	15AU743	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: At the end of the course the student will be able to

1. Calculate viscous force developed in oil between parallel plates.
2. Develop mathematical models for tribological processes
3. Design journal bearings.
4. Design hydrostatic bearings for optimal performance.
5. Select bearing materials
6. Explain different aspects of tribological properties.

Module-I	
Introduction: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubricationprinciples, classification of lubricants.	08 Hours
Module-II	
Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D, numerical problems.	08 Hours
Module-III	
Idealized Journal Bearing: Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; Partial bearings, end leakages in journal bearing, numerical problems.	08 Hours
Module-IV	
Oil Flow and Thermal Equilibrium of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings. **Hydrostatic Lubrication:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.	08 Hours
Module-V	
Bearing Materials: Commonly used bearings materials, properties of typical bearing materials, advantages and disadvantages of bearing materials.	08 Hours

Behavior of Tribological Components: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering	

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

1. Calculate viscous force developed in oil between parallel plates.
2. Develop mathematical models for tribological processes
3. Design journal bearings.
4. Design hydrostatic bearings for optimal performance.
5. Select bearing materials
6. Explain different aspects of tribological properties.

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. Fundamentals of Tribology -Basu S. K., Sengupta A N., Ahuja B.B., PHI 2006.
2. Introduction to Tribology Bearings -Mujumdar B. C., S. Chandcompany Pvt. Ltd. 2008.

Reference Books:

1. Theory and Practice of Lubrication for Engineers -Fuller, D.,New York company 1998
2. Principles and Applications of Tribology -Moore, Pergamaonpress 1998
3. Tribology in Industries - Srivastava S., S Chand and Companylimited, Delhi 2002.
4. Lubrication of bearings – Theoretical Principles and Design - Redzimovskay E I., Oxford press company 2000.

ENGINEERING SYSTEM DESIGN

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

SEMESTER – VII

Subject Code	15AU744	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: At the end of the course the student will be able to

1. Develop an understanding of the Systems Engineering Process and the range of factors that influence the design, planning, production, evaluation and use of a system.
2. Understand the concepts of and develop skills in the design, construction, fault-finding, diagnosis, performance analysis, maintenance, modification, and control of technological systems.
3. Acquire knowledge of new developments and innovations in technological systems.
4. Develop an understanding of how technologies have transformed people's lives and can be used to solve challenges associated with climate change, efficient energy use, security, health, education and transport.
5. Gain an awareness of quality and standards, including systems reliability, safety and fitness for the intended purpose.

Module-I	
Introduction Definition of designing, Man as a designer: Design by evolution, inadequacies of traditional design method: System approach of engineering problems: Need models: design history of large scale existing system. **Morphology of design:** The three phases of design projects, the structure of design process, decision making and iteration.	08 Hours
Module-II	
Identification and analysis of Need: Preliminary need statement, analysis of need, specifications, and standards of performance and constrains. **Origination of Design Concept:** Process of idealization, mental fixity, and some design methods like morphological analysis, AIDA, brainstorming etc	08 Hours
Module-III	
Preliminary Design: Mathematical modeling for functional design: concept of sensitivity, compatibility and stability analysis. **Reliability Considerations in Design:** Bath tub curve, exponential reliability function, system reliability concept. (Numerical).	08 Hours

Module-IV	
Evaluation of Alternatives and Design decisions: Physical realisability, Design Tree: Quality of design, Concept of utility, multi criteria decisions, decisions under uncertainty and risk (Numerical). **Economics and Optimization in Engineering Design:** Economics in Engineering Design, Fixed and variable costs, break-even analysis. (Numerical).	08 Hours
Module-V	
Optimization: Introduction to LPP, formulation and graphical solutions. **Man- Machine Interaction:** Designing for use and maintenance, Man-Machine Cycle, Design of displays and controls. Factors influencing displays and controls.	08 Hours

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

1. Develop an understanding of the Systems Engineering Process and the range of factors that influence the design, planning, production, evaluation and use of a system.
2. Understand the concepts of and develop skills in the design, construction, fault-finding, diagnosis, performance analysis, maintenance, modification, and control of technological systems.
3. Acquire knowledge of new developments and innovations in technological systems.
4. Develop an understanding of how technologies have transformed people's lives and can be used to solve challenges associated with climate change, efficient energy use, security, health, education and transport.
5. Gain an awareness of quality and standards, including systems reliability, safety and fitness for the intended purpose.

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. An Introduction to Engineering Design Method - by V. Gupta and P. Murthy, Tata McGraw Hill. 2000
2. Introduction of Engineering Design by T. Woodson, McGraw Hil1.2001

Reference Books:

1. Design & Planning of Engineering systems - D.D. Meredith, K.W. Wong, R.W. Wood head & K.K. Worthman. 2000.
2. Introduction to Design - by M.A. Asimov-Prentice Hall. 1996.
3. Design Methods - Seeds of Human Futures-Wiley Inter Science.1970.

CONTROL ENGINEERING

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

SEMESTER – VII

Subject Code	15AU751	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: At the end of the course the student will be able to

1. Differentiate between open loop and closed loop control systems with practical examples.
2. Solve a complex control system to simple form using block diagrams and signal flow graph.
3. Evaluate the response of a control system for step & ramp inputs using differential equations.
4. Analyze stability of a given system by using polar, Nyquist, bode plots and root locus concepts.
5. Explain need for system compensations.

Module-I	
Introduction: Classifications of control systems open and closed loop systems, concepts of feedback and feed forward control systems, requirement of an ideal control system, types of controllers. **Mathematical models:** Transfer function models, models of mechanical systems, models of electrical circuits, models of thermal systems, models of hydraulic systems, Pneumatic system, DC and AC servomotors in control systems. Error detectors	08 Hours
Module-II	
Block diagrams and signal flow graphs: Transfer Functions definition, blocks representation of system elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula.	08 Hours
Module-III	
Transient and steady state response analysis Introduction, Analysis of first order and second order system response to step, ramp and impulse inputs, Transient response and time domain specifications. System stability: Routh's-Hurwitz Criterion.	08 Hours
Module-IV	
Frequency Response Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin. Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams.	08 Hours
Module-V	

Root Locus Plots: Definition of root loci, General rules for constructing rootloci, Analysis using root locus plots. **System Compensation and State Variable Characteristics of Linear Systems:** Series and feedback compensation, Introduction to state concepts,state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test**.**	08 Hours

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

1. Differentiate between open loop and closed loop control systems with practical examples.
2. Solve a complex control system to simple form using block diagrams and signal flow graph.
3. Evaluate the response of a control system for step & ramp inputs using differential equations.
4. Analyze stability of a given system by using polar, Nyquist, bode plots and root locus concepts.
5. Explain need for system compensations.

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. Modern Control Engineering -Katsuhiko Ogatta, PearsonEducation,2004.
2. Control Systems Principles and Design -M.Gopal, 3rd Ed.,TMH,2000.

Reference Books:

1**.** Modern Control Systems - Richard.C.Dorf and Robert.H.Bishop,Addison Wesley,1999
2. System Dynamics &Control -Eronini, Umez, Thomson Asia Pvt. Ltd. Singapore, 2002.
3. Feedback Control System - Schaum's series. 2001.

ENGINEERING ECONOMY

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

SEMESTER – VII

Subject Code	15AU752	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: At the end of the course the student will be able to

1. Solve the problem related to decision making regarding supply and demand.
2. Understand the concept of interest and time value of money.
3. Make the decision based on present worth, future worth of the alternatives.
4. Understand the financial statements for making suitable decisions.

Module-I	
Introduction: Engineering Decision-Makers, Engineering and Economics,Problem solving and Decision making, Intuition and Analysis, Tactics andStrategy. Engineering Economic Decision Maize, Law of demand andsupply, Law of returns, Interest and Interest factors: Interest rate, Simpleinterest, Compound interest, Cash - flow diagrams, Personal loans and EMIPayment, Exercises and Discussion.	08 Hours
Module-II	
Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Presentworth, Assets with unequal lives, infinite lives, Future-worth comparison,Pay-back comparison, Exercises, Discussions and problems.	08 Hours
Module-III	
Rate-of-Return Calculations And Depreciation: Rate of return, Minimumacceptable rate of return, IRR, IRR misconceptions, Cost of capital concepts, Causes of Depreciation, Basic methods of computing depreciation charges,Tax concepts, and corporate income tax.	08 Hours
Module-IV	
Rate-Of-Return Calculations And Depreciation: Rate of return, Minimum, acceptable rate of return, IRR, IRR misconceptions, Cost of capital concepts, Causes of Depreciation, Basic methods of computing depreciation charges,Tax concepts, corporate income tax. **Estimating and Costing:** Components of costs such as Direct MaterialCosts, Direct Labor Costs, Fixed Over-Heads, and Factory cost, AdministrativeOver-Heads, First cost, Marginal cost, Selling price, Estimation for simplecomponents.	08 Hours
Module-V	

Introduction, Scope of Finance, Finance Functions: Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. Simple Numerical. **Financial and Profit Planning:** Introduction, Financial planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting (No numericals).	08 Hours
Course outcomes: After completion of above course, students will be able to 1. Solve the problem related to decision making regarding supply and demand. 2. Understand the concept of interest and time value of money. 3. Make the decision based on present worth, future worth of the alternatives. 4. Understand the financial statements for making suitable decisions.	
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. Engineering Economy - Riggs J.L., 4TH ed. , McGraw Hill, 2002 2. Engineering Economy - Thuesen H.G. PHI , 2002.	
Reference Books: 1. Engineering Economy - Tarachand, TMH, 2000. 2. Industrial Engineering and Management – O.P. Khanna, DhanpatRai& Sons. 2000. 3. Financial Mangement- Prasanna Chandra, 7th Ed., TMH, 2004. 4. Finacial Management – I. M. Pandey, Vikas Pub. House, 2002.	

OPERATIONS RESEARCH

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

SEMESTER – VII

Subject Code	15AU753	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: At the end of the course the student will be able to

1. Formulate a problem as LPP.
2. Solve LPP of different models using suitable method.
3. Plan and execute the projects using CPM and PERT techniques.
4. Decide the optimum sequence of the processes/ machines.

Module-I	
Introduction: Evolution of OR, definition of OR, scope of OR, applicationareas of OR, steps (phases) in OR study, characteristics and limitations ofOR, models used in OR, linear programming (LP) problem-formulation andsolution by graphical method. **Solution of Linear Programming Problems**: The simplex methodcanonicaland standard form of an LP problem, slack, surplus and artificialvariables, big M method and concept of duality, dual simplex method.	08 Hours
Module-II	
Transportation Problem: Formulation of transportation problem, types,initial basic feasible solution using different methods, optimal solution byMODI method, degeneracy in transportation problems, application oftransportation problem concept for maximization cases. **AssignmentProblem:** Formulation, types, application to maximization cases and travellingsalesman problem	08 Hours
Module-III	
Integer Programming: Pure and mixed integer programming problems,solution of Integer programming problems-Gomory's all integer cuttingplane method and mixed integer method, branch and bound method, Zero- One programming. **Queuing Theory:** Queuing systems and their characteristics, Pure-birth andPure-death models (only equations), empirical queuing models – M/M/1 andM/M/C models and their steady state performance analysis.	08 Hours
Module-IV	

PERT-CPM Techniques: Introduction, network construction – rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Criticalpath method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining theprobability of completing a project, predicting the completion time of project;crashing of simple projects.	08 Hours
Module-V	
Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **Sequencing:** Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method	08 Hours

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

1. Formulate a problem as LPP.
2. Solve LPP of different models using suitable method.
3. Plan and execute the projects using CPM and PERT techniques.
4. Decide the optimum sequence of the processes/ machines.

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. Operations Research–P. K. Gupta and D S Hira, ChandPublications, New Delhi – 2007.
2. Operations Research - Taha H A, Pearson Education.
3. Operations Research -S.D. Sharma, LedarnathRamanath& Co,2002.

Reference Books:

1. Operations Research- A. P.Verma, S K Kataria&Sons, 2008.
2. Operations Research -Paneerselvan, PHI.
3. Operations Research –A. M.Natarajan, P Balasubramani, PearsonEducation, 2005.
4. Introduction to Operations Research -Hillier and Liberman,8thEd., McGraw Hill.

TWO AND THREE WHEELED VEHICLE

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

SEMESTER – VII

Subject Code	15AU754	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: At the end of the course the student will be able to:

1. Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles.
2. Laydown wiring diagram for two wheeler and three wheeled vehicles.
3. Explain types of clutches, transmission and final drives used for two and three wheeled vehicles.
4. Describe types of frames, brakes and tyres used for two and three wheeled vehicles.
5. Laydown maintenance schedule for two and three wheeled vehicles.

Module-I	
The Power Unit: Types of engines for two wheelers, advantages and disadvantages of two stroke and four stroke engines, engine components, constructional details, materials, symmetrical and unsymmetrical port timing diagrams, valve actuating mechanisms, valve timing diagrams. Rotary valve engine, Advantages and disadvantages of diesel engines for two wheelers, power plant for electric bikes, exhaust systems.	08 Hours
Module-II	
Fuel, Lubrication and Cooling system: Layout of fuel supply system, fuel tank construction, carburetor types, construction, working and adjustments. Types of cooling systems, advantages of air cooling system. Lubrication types, Lubrication of parts, grades of lubricating oils. **Electrical system**: Types of ignition system, their working principles, wiring diagram for Indian vehicles, spark plug construction, indicators and gauges used in two wheelers, lighting systems.	08 Hours
Module-III	
Transmission system: **Primary drive and Clutch:** Motor cycle power train, Primary drives, Types of primary drives, Chain drive, Gear drive, Construction and operation of motorcycle clutches, Clutch release mechanism. Gear boxes and **Transmission:** Introduction to motorcycle transmission, Sprockets and chain, Gears and Dogs in motor cycle transmission, Gear and Gear ratios, Sliding gear transmissions, Shifting fork mechanisms, Constant mesh transmissions, lubrication, **Final drive:**	08 Hours

Introduction to motorcycle final drives, Fundamentals of chain drive, Chain lubrication and lubricators, Shaft drives, Drive shaft couplings, Final drive gear case,	
Module-IV	
Frames and suspension: Types and constructional details of frames, advantages and limitations, frame materials, frame stresses, frame building problems, frame components, Front and Rear suspension systems, shock absorber construction and working, Panel meters and controls on handle bar, body manufacture and painting. **Brakes and Wheels**: Front and rear braking systems, disc and drum brakes, merits and demerits, Types of wheels, loads on wheels, construction and materials for wheels, wheels designation,tyre designation, inflation, types of tyres, construction details.	08 Hours
Module-V	
Two wheelers and Three wheelers: Case study of major Indian models of major motor cycles, scooters, scooteretts and mopeds. Case study of Indian models of three wheelers, Front mounted engine and rear mounted engine types, Auto rickshaws, pick up van, delivery van and trailer, Bijlielectric vehicles. **Maintenance:** Importance of maintenance, Decarburizing procedure for engine and silencer, periodic inspection, maintenance schedules, trouble diagnosis charts, safety precautions, Lubrication charts.	08 Hours

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

1. Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles.
2. Laydown wiring diagram for two wheeler and three wheeled vehicles.
3. Explain types of clutches, transmission and final drives used for two and three wheeled vehicles.
4. Describe types of frames, brakes and tyres used for two and three wheeled vehicles.
5. Laydown maintenance schedule for two and three wheeled vehicles.

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. Motor cycle engines - P.E.Irving, Temple Press Book, London, 1992
2. Motor cycles -Michel M. Griffin
3. Motor cycle Mechanics - William H. Crouse and Donald L. Anglin, TMH

Reference Books:

1. The cycle Motor manual - Temple Press Ltd, 1990
2. Vespa maintenance and repair series - Bryaut R. V.
3. Encyclopedia of Motor Cycling 20 volumes - Marshall Cavendish, New York., 1989

AUTOMOBILE SCANNING AND RE-CONDITIONING LAB

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

SEMESTER –VII

Subject Code	15AUL76	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:At the end of the course the student will be able to:

1. Check and adjust ignition timing and tappet clearance
2. Align the given connecting rod
3. Rebore the given engine cylinders
4. Service the FIP and calibrate
5. Repair the vehicle body and paint it

PART – A

1. Inspection of vehicles and preparation of test charts.
2. Tuning of Engines: Check for ignition timing, valve tappet clearance, Radiator flushing and check for leaks etc.,
3. Study and practice on
   a. Connecting rod alignment
   b. Cylinder reboring machine
   c. Valve refacing machine
   d. Nozzle grinding machine
   e. Brake drum skimming machine

PART-B

1. Servicing of FIP, Calibration and phasing of FIP.
2. Study and practice of wheel balancing and wheel alignment.
3. Testing of Two wheeled vehicles on chassis dynamometer.
4. Study of tyre retreading and vulcanizing.
5. Study and practice on body repairs – tinkering and painting.
6. Head light focusing test and visibility test.

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

1. Check and adjust ignition timing and tappet clearance
2. Align the given connecting rod
3. Rebore the given engine cylinders
4. Service the FIP and calibrate
5. Repair the vehicle body and paint it

Scheme of Examination:

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

MODELING AND ANALYSIS LAB

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

SEMESTER –VII

Subject Code	15AUL77	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: At the end of the course the student will be able to:

1. Describe procedure for FEA
2. Model and analyze bar, beam and trusses subjected to various types of loads
3. Analyze heat transfer and flow processes

PART – A

Study of FEA packages, Modeling, Static and Dynamic analysis

STATIC ANALYSIS

1. Bars subjected to axial loads for constant cross section, tapered cross section and stepped bar.
2. Trusses – Simple trusses
3. Beams – Cantilever and simply supported beams subjected to point load,UDL, UVL and moments.

PART-B

1. Beams subjected to axial and bending loads.
2. Thermal analysis – 2D problems with conduction and convection.
3. Fluid flow analysis- simple and 2 D problems.

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

1. Describe procedure for FEA
2. Model and analyze bar, beam and trusses subjected to various types of loads
3. Analyze heat transfer and flow processes

Scheme of Examination:

One Question from Part – A 30 marks

One Question from Part – B 40 marks

Viva – Voce 10 marks

Total: 80 marks

Project Phase- I + Project seminar [As per Choice Based Credit System (CBCS) scheme] SEMESTER –VII			
Subject Code	15AUP78	IA Marks	100
Number of Lecture Hours/Week	03	Exam Marks	
Total Number of Lecture Hours		Exam Hours	03
Credits	02		

During project Phase – I , students are expected to

1. Identify the project domain and topic
2. Carryout necessary literature survey
3. Define the problem for consideration
4. Finalizing the methodology to carry out the project work in Phase- II.
5. Present seminar on topic selected for project

VEHICLE BODY ENGINEERING AND SAFETY

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

SEMESTER – VIII

Subject Code	15AU81	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: at the end of this course, students will be able to:

1. Classify the vehicles and define basic terms.
2. Select appropriate body material.
3. Calculate various aerodynamic forces and moments acting on vehicle.
4. Calculate load distribution in vehicle body.
5. Explain the ergonomics, stability the vehicle.
6. Identify the various safety aspects in a given vehicle.
7. Identify various sources of noise and methods of noise separation.

Module-I	
Classification of coachwork : Styling forms, coach and bus body style, layout of cars, buses and coach with different seating and loading capacity, commercial vehicle types, Vans and Pick ups. Terms used in body building construction, Angle of approach, Angle of departure, Ground clearance, Cross bearers, Floor longitudes, posts, seat rail, waist rail, cant rail, Roof stick, Roof longitude, Rub rail, skirt rail, truss panel, wheel arch structure, wheel arch, post diagonals, gussets.	10 Hours
Module-II	
Vehicle Body Materials: Aluminium alloys, Steel, alloy steels, plastics, Metal matrix composites, structural timbers - properties, glass reinforced plastics and high strength composites, thermoplastics, ABS and styrenes, load bearing plastics, semi rigid PUR foams and sandwich panel construction. Paints adhesives and their properties, corrosion and their prevention.	10 Hours
Module-III	
Aerodynamics: Basics, Vehicle drag and types, Various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, Principle of wind tunnel technology, flow visualization techniques, tests with scale models, aerodynamic study for heavy vehicles. **Load distribution:** Type of body structures, Vehicle body stress analysis, vehicle weight distribution, Calculation of loading for static loading, symmetrical, longitudinal loads, side loads, stress analysis of bus body structure under bending and torsion.	10 Hours
Module-IV	
Interior Ergonomics: Introduction, Seating dimensions, Interior ergonomics, ergonomics system design, seat comfort, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin	10 Hours

ergonomics, mechanical package layout, goods vehicle layout. Visibility, regulations, drivers visibility, methods of improving visibility, Window winding and seat adjustment mechanisms. **Vehicle Stability:** Introduction, Longitudinal, lateral stability, vehicle on a curvilinear path, critical speed for toppling and skidding. Effect of operating factors on lateral stability, steering geometry and stabilization of steerable wheels, mass distribution and engine location on stability.	
Module-V	
Noise and vibration: Noise characteristics, Sources of noise, noise level measurement techniques, Body structural vibrations, chassis bearing vibration, designing against fatigue, methods of noise suppression. **Impact protection:** basics, Physics of impact between deformable bodies, Design for crash worthiness, occupant and cargo restraint, passive restraint systems, side impact analysis, bumper system, energyabsorbent foams, laws of mechanisms applied to safety	10 Hours

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

1. Classify the vehicles and define basic terms.
2. Select appropriate body material.
3. Calculate various aerodynamic forces and moments acting on vehicle.
4. Calculate load distribution in vehicle body.
5. Explain the ergonomics, stability the vehicle.
6. Identify the various safety aspects in a given vehicle.
7. Identify various sources of noise and methods of noise separation

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. Body Engineering -Sydney F page, Chapman & Hall Ltd, London, 1956
2. Vehicle body engineering - Giles J Pawlowsky, Business books limited, 1989
3. Vehicle body layout and analysis - John Fenton, MechanicalEngg. Publication ltd, London.

Reference Books:

1. Hand book on vehicle body design – SAE publication.
2. Automotive chassis - P.M. Heldt, Chilton & Co, 1970
3. Vehicle Safety 2002 -Cornwell press, Townbridge, UK, ISBN 1356 -1448.
4. Redesign of bus bodies – part I & part II – CIRT pune (Report), 1983
5. Aerodynamics of Road Vehicles - Ed W.H. Hucho, 4th Edition, Butter worth's 1987
6. Road Vehicle Aerodynamics - Scibor-Rylski A. J.,Pentech press, London 2nd Edition 1984
7. Low Speed Wind Tunnel Testing - Rae W.H. & Pope A, Wiley & Sons, USA 1984

MECHANICAL VIBRATIONS

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

SEMESTER – VIII

Subject Code	15AU82	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: at the end of this course, students will be able to:

1. Classify different types of vibration / damping associated with systems and vibration measuring instruments.
2. Calculate natural frequency, damping, logarithmic decrement and other parameters of single degree of freedom un-damped / damped free vibrating systems
3. Compute the response of single degree of freedom damped vibrating systems to different excitation forces.
4. Determine the natural frequencies and the modes of two degree of freedom free vibrating systems
5. Compare the natural frequencies / modes of multi-degree of freedom free vibrating systems using numerical methods

Module-I	
Introduction: Types of vibration, Simple harmonic motion and definition of some terms of vibration, Vector method and complex form of representing harmonic motions, addition of simple harmonic motions. **Undamped free vibration**: Introduction, Newton's second law of motion method, D'Alembert's principle, Energy method, Single degree of freedom systems, Natural frequency of free vibration, equivalent stiffness of springs, effect of spring mass.	10 Hours
Module-II	
Damped free vibration: Single degree of freedom systems, types of damping, concept of critical damping and its importance, study of viscous damped systems - under damping, critical damping and over damping, logarithmic decrement, structural and coulomb damping. **Whirling of shafts**: Whirling of shafts with and without air damping, discussion of speeds above and below critical speeds.	10 Hours
Module-III	
Forced vibration: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force, concept of frequency response, reciprocating and rotating unbalance, vibration isolation and transmissibility, energy dissipated by damping, equivalent viscous damping, Structural damping, sharpness of resonance, base excitation.	10 Hours
Module-IV	
Two degree of freedom systems: Introduction, principle and normal modes of vibration, co-ordinate coupling,	10 Hours

generalized and principal co-ordinates, orthogonality principle, Lagrange's equation, semi-definite systems, forced vibrations, harmonic excitation. Applications: Vehicle suspension, Dynamic vibration absorber, dynamics of reciprocating engines. **Vibration measuring instruments** Vibrometer, Accelerometer and frequency measuring instruments.	
Module-V	
Multi degree of freedom systems: Introduction, influence coefficients, Maxwell's reciprocal theorem, orthogonality principle, Dunker ley's equation, determination of natural frequencies using matrix iteration method, Holzer's method for systems with free, fixed free and fixed ends, stodola method, Rayleigh's method for beam vibration	10 Hours

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

1. Classify different types of vibration / damping associated with systems and vibration measuring instruments.
2. Calculate natural frequency, damping, logarithmic decrement and other parameters of single degree of freedom un-damped / damped free vibrating systems
3. Compute the response of single degree of freedom damped vibrating systems to different excitation forces.
4. Determine the natural frequencies and the modes of two degree of freedom free vibrating systems
5. Compare the natural frequencies / modes of multi-degree of freedom free vibrating systems using numerical methods

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. Mechanical Vibrations, G. K. Grover and S. P. Nigam, Nemchand and Brothers, Roorkee.
2. Mechanical Vibrations: V.P. Singh, DhanpatRai and Sons, New Delhi

Reference Books:

1. Theory and Problems of Mechanical Vibrations - William W. Seto, McGraw Hill International BookCo., Singapore (Schaum's outline series)
2. Mechanical Vibrations -S. S. Rao, Pearson Education Inc.,
3. Mechanical Vibrations -S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill Publishing Co.Ltd., New Delhi
4. Theory and Practice of Mechanical vibrations - J. S. Rao and K. Gupta, New Age InternationalPublications, New Delhi
5. Elements of Vibrations Analysis - Leonard Meirovitch, Tata McGraw Hill, New Delhi

TOTAL QUALITY MANAGEMENT

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

SEMESTER – VIII

Subject Code	15AU831	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: at the end of this course, students will be able to:

1. Explain basic concepts of TQM
2. Describe leader ship qualities, different factors of customer satisfaction and benefits of involvement of employee in quality management
3. Describe various techniques for continuous process improvement and to understands its benefits
4. Apply various tools and techniques in industries to achieve the higher productivity
5. Describe importance of HR dept. recruitment process, importance of training of employees
6. Understand use of various graphical representation of process behavior in TQM

Module-I	
Introduction to TQM Introduction-Definition, Basic Approach, and Contribution of Gurus - TQM framework, Historical Review,Benefits of TQM, TQM organization. **Leadership, Customer Satisfaction and Employee Involvement:** Characteristics of quality leaders, Customers satisfaction, Customer perception of quality, Feedback, Using customer's complaints, Employee involvement - Introduction, Teams, Cross functional teams, Quality circles, Suggestion system, Benefits of employee involvement.	08 Hours
Module-II	
Continuous process Improvement and tools techniques: The juran trilogy, improvement strategies, types of problems, the PDSA cycle, problem solving methods, Kaizen, reengineering, six sigma, Process of benchmarking, quality function deployment, quality by design, failure mode and FME analysis, case studies	08 Hours
Module-III	
Quality Mangement tools Why- why forced filed analysis, nominal group techniques, affinity diagram, interrelationship diagram, Tree diagram, matrix diagram, process decision programme chart, activity network diagram, prioritization matrices	08 Hours
Module-IV	
Human Resource Practices: Scope of Human Resources Management, leading practices, designing high performance work systems-work and job design, Recruitment and career development, Training and education, Compensation and recognition, Health, safety and employee well-being, performance appraisal.	08 Hours
Module-V	
Statistical process control Paratodigram, process flow diagram, fishbone diagram, histograms, check sheets, statistical fundamentals. Control charts, types of control charts, scattered	08 Hours

diagrams case studies and numerical problems	

Course outcomes: After learning all the modules of the course, the studentswill be able to

1. Explain basic concepts of TQM.
2. Describe leader ship qualities, different factors of customer satisfaction and benefits of involvement of employee in quality management
3. Describe various techniques for continuous process improvement and to understands its benefits
4. Apply various tools and techniques in industries to achieve the higher productivity
5. Describe importance of HR dept. recruitment process, importance of training of employees
6. Understand use of various graphical representation of process behavior in TQM

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full 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. Total Quality Management - Dale H. Besterfield, Pearson Education India, ISBN: 8129702606, Edition 03/e Paperback (Special Indian Edition)
2. The management and control of Quality - James R. Evans and William M.Lindsay, ISBN: 981-243-552-0 , Publisher - Thomson South-Western, Edition –6

Reference Books:

1. Total Quality Management for Engineers - M. Zairi, ISBN: 1855730243, Woodhead Publishing.
2. 100 Methods for Total Quality Management -Gopal K. Kanji and Mike Asher , ISBN: 0803977476, Publisher: Sage Publications, Inc.; Edition – 1

DATABASE MANAGEMENT SYSTEM

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

SEMESTER – VIII

Subject Code	15AU832	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 at the end of this course, students will be able to:

1. Explain the advantages of using DBMS as an approach to bookkeeping
2. Discuss entity-relationship model as the basis for the design of DBMS
3. Describe relational model and relational algebra as the basis for the design of DBMS languages like SQL
4. Apply SQL statements against an existing DBMS
5. Develop a specimen database using SQL in conformance with the rules of normalization.
6. Describe transactional management and its intricacies.

Module-I	
Introduction: Introduction; Characteristics of Database approach; Advantages of using DBMS approach; Data models, schemas and instances; Three-schema architecture and data independence, The database system environment; Centralized and client-server architectures; Classification of Database Management systems. **Entity-Relationship Model:** Using High-Level Conceptual Data Models for Database Design; An Example Database Application; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets, Roles and Structural Constraints; Weak Entity Types; Refining the ER Design; ER Diagrams, Naming Conventions and Design Issues; Relationship types of degree higher than two.	08 Hours
Module-II	
Relational Model and Relational Algebra : Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations, Transactions and dealing with constraint violations; Unary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Binary Relational Operations : JOIN and DIVISION; Additional Relational Operations; Examples of Queries in Relational Algebra; Relational Database Design Using ER- to-Relational Mapping.	08 Hours
Module-III	
SQL – 1: SQL Data Definition and Data Types; Specifying basic constraints in SQL, Schema change statements in SQL, Basic queries in SQL, More complex SQL Queries. **SQL – 2 :** Insert, Delete and Update statements in SQL, Specifying constraints as Assertion and Trigger; Views (Virtual Tables) in SQL, Additional features of SQL, Database programming issues and techniques.	08 Hours
Module-IV	

Database Design: Informal Design Guidelines for Relation Schemas; Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form, Properties of Relational Decompositions; Algorithms for Relational Database Schema Design; Multivalued Dependencies and Fourth Normal Form; Join Dependencies and Fifth Normal Form; Inclusion Dependencies; Other Dependencies and Normal Forms.	08 Hours
Module-V	
Transaction Management: The ACID Properties; Transactions and Schedules; Concurrent Execution of Transactions; Lock- Based Concurrency Control; Performance of locking; Transaction support in SQL; Introduction to crash recovery; 2PL, Serialiazability and Recoverability; Lock Management; Introduction to ARIES; The log; Other recovery-related structures; The write-ahead log protocol; Check pointing; Recovering from a System Crash; Media Recovery; Other approaches and interaction with concurrency control.	08 Hours

Course outcomes: After learning all the modules of the course, the student will be able to

1. Explain the advantages of using DBMS as an approach to bookkeeping
2. Discuss entity-relationship model as the basis for the design of DBMS
3. Describe relational model and relational algebra as the basis for the design of DBMS languages like SQL
4. Apply SQL statements against an existing DBMS
5. Develop a specimen database using SQL in conformance with the rules of normalization.
6. Describe transactional management and its intricacies.

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. Fundamentals of Database Systems- RamezElmasri and Shanmkanth B. Navathe, 3rd Edition, Addison Pearson.
2. Database Management System Use - by Raghu Ramakrishnan, Tata McGraw Hill, 3rd Edn. 2002.

Reference Books:

1. Database Managaement and design - by Gray W.Hansen and James V. Hansen, 2nd Edn. PrinticeHall India Pvt. Ltd., 2002.
2. Database Management Systems- Designing and Building business applications, Gerald V. Post, 3rd Edition, Tata McGraw Hill Publishing company Ltd., - 2005
3. Project Management with PERT and CPM, Moder Joseph J and Phillips Cerel, R., VAN Noserand,
4. Reinhold, 2nd Edn., 1976.

ADVANCED I.C. ENGINES

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

SEMESTER – VIII

Subject Code	15AU833	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:at the end of this course, students will be able to:

1. Explain combustion phenomenon in SI and CI Engines also factors effecting combustion variations in these engines
2. Calculate mixture requirement and pollutants produced in internal combustion engines.
3. Determine efficiency and power output from brayton cycle
4. Explain basic concepts of lean burn engine, sterling engine, cam less engine, multi valve engine etc.
5. Explain working of modern engines.

Module-I	
Combustion in Spark Ignition Engines: Thermodynamic analysis of SI engine Combustion: Burned and unburned mixture states. Analysis of cylinder pressure data, Combustion process characterization, Flame structure and speed; flame structure, laminar burning speeds, flame propagation relations, Cyclic variations in combustion, partial burning and misfire: definitions, causes of cycle – by – cycle and cylinder to cylinder variations, partial burning, misfire and engine stability. Spark Ignition: Ignition fundamentals, conventional ignition systems, alternative ignition systems, alternative ignition approaches, Abnormal Combustion: knock and surface ignition, knock fundamentals, fuel factors.	08 Hours
Module-II	
Combustion in Compression Ignition Engines: Types of diesel combustion systems: Direct injection systems, indirect injection systems, comparison of different combustion systems, Analysis cylinder pressure data; combustion efficiency, DI engines, IDI engines, Fuel spray behaviour: Fuel injection, overall spray structure, atomization, spray penetration, droplet size distribution and spray evaporation, Ignition delay: definitions and discussion, fuel ignition quality, auto ignition fundamentals, physical properties affecting delay, effect of fuel properties.	08 Hours
Module-III	
Equilibrium charts: Charts for burnt mixture, charts for unburned Mixture, transmission from unburned to burnt mixture, non- equilibrium Problems. **Gas Turbine combustion:** Simple brayton cycle, working of a gas turbine, modification of the simple cycle, intercooling reheat and regeneration, determination of efficiency and power output, numerical problems.	08 Hours
Module-IV	
Modern Developments in I. C. Engines: Lean burn engines, ceramic and adiabatic engines, Multi-valving, Tuned	08 Hours

manifolding, camless valve gearing, variable valve timing, Turbo and supercharging – Waste gating, EGR, Part-load charge stratification in GDI systems. Sports vehicle engines, Stirling engines, MPFI engines – operation and performance.	
Module-V	
Special types of Engines; Introduction to working of startified charged engines, Wankel engine, variable compression engine, Surface ignition engines, free piston engines, Current engines and future trends (e.g. Convergence of SI and CI engine technology, Control developments, fuel quality), Effect of air cleaners and silencers on engine performance.	08 Hours

Course outcomes: After learning all the modules of the course, the student will be able to

1. Explain combustion phenomenon in SI and CI Engines also factors effecting combustion variations in these engines
2. Calculate mixture requirement and pollutants produced in internal combustion engines.
3. Determine efficiency and power output from brayton cycle
4. Explain basic concepts of lean burn engine, sterling engine, cam less engine, multi valve engine etc.
5. Explain working of modern engines.

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. Internal Combustion Engines Fundamentals - John B. Heywood, McGraw Hill International Edition,
2. A course in I.C. Engines - Mathur& Sharma, DhanpatRai& sons, New Delhi,1994.

Reference books:

1. Internal Combustion Engines- Ganesan, V, Tata McGraw Hill Book Co., 1995.
2. Internal Combustion Engine Fundamentals- John B. Heywood, McGraw Hill Book, 1998.
3. Internal Combustion Engine and Air Pollution- Obert, E.F., International Text Book Publishers, 1983.
4. I.C. Engines by Maleev- CBS Publications, New Delhi.

MAINTENANCE ENGINEERING

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

SEMESTER – VIII

Subject Code	15AU834	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:at the end of this course, students will be able to:

1. Explain maintenance strategies.
2. Plan maintenance schedule and methods for preventive and bre4ak down maintenance.
3. Find most optimal maintenance frequency.
4. Explain use of computers in maintenance of machinery.
5. Analysis of accident records and accident Safety standards for Mechanical equipment.
6. Explain safety standards for mechanical, electrical and chemical systems.

Module-I	
Introduction to Maintenance System: Definition, Scope, Objective, functions and Importance of maintenance system, Type of maintenance system, Break down maintenance system. Preventive maintenance, Predictive maintenance, design out maintenance, corrective maintenance, planned maintenance, total productive maintenance, condition monitoring. Problems on selection of methods like preventive or breakdown maintenance,	08 Hours
Module-II	
Maintenance of Machinery: Causes of machine failure, performance evaluation, complete overhauling of Machines tools. Maintenance planning and scheduling. Repair order control manpower requirement, Maintenance job analysis spare parts control.	08 Hours
Module-III	
Economics in Maintenance: Repair, replacement, Repair complexity, Finding out most optimal preventive maintenance frequency. Numerical treatment required **Maintenance Planning:** Planning of maintenance junctures manpower allocation, long range planning, short range planning. Planning techniques and procedures. Estimation of maintenance work. Maintenance control.	08 Hours
Module-IV	
Computers in maintenance: Features and benefits of Computer aided maintenance. Application of computers to maintenance work. **Industrial Safety:** Economic importance of accidents, Types of safety organizations, Analysis of accident records, accident investigations, Analysis of accident Safety standards for Mechanical equipment	08 Hours
Module-V	
Safety standards: Safety standards for Electrical equipment and systems. Chemical hazards,	08 Hours

material handling, exhaust systems, welding, Plant housekeeping-building, Aisles, passages, floors, tool cribs, washrooms, canteens.

Industrial Pollution Control:

Dust control -Fibre collectors, mechanical dust collectors, wet type collectors, Electro static precipitators, Noise pollution Control - Noise measurement and control. Industrial vibration and its control.

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

1. Explain maintenance strategies.
2. Plan maintenance schedule and methods for preventive and bre4ak down maintenance.
3. Find most optimal maintenance frequency.
4. Explain use of computers in maintenance of machinery.
5. Analysis of accident records and accident Safety standards for Mechanical equipment.
6. Explain safety standards for mechanical, electrical and chemical systems.

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 Maintenance Engineering and Management - R.C.Mishra and K.Pathak, Prentice Hall of India, 2002

1. Maintenance Engineering Hand book - Morrow.

Reference Books:

1. Hand book of Maintenance Management - Frank Herbaty
2 Hand book of Industrial Engg& Management - W. Grant Lreson& Eugene L-Grant
3 Industrial Pollution Control Handbook - LUND *A.*
4 Industrial Maintenance - H P Garg
5 Maintenance Engineering Hand book- Lindrey Higgins, McGraw Hill, 5th edition, 2003.

Internship/Professional Practice
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –VII

Subject Code	15AU84	IA Marks	50
Number of Lecture Hours/Week		Exam Marks	50
Total Number of Lecture Hours		Exam Hours	03
Credits	02		

Course objectives: At the end of the course the student will be able to:

1. Apply classroom and laboratory concepts and principles in an industry work environment.
2. To demonstrate the ability to work as a team member to successfully complete the assigned work

The duration and modalities for internship will be as per VTU rules and regulations.

Project work Phase II
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER –VII

Subject Code	15AUP85	IA Marks	100
Number of Lecture Hours/Week		Exam Marks	100
Total Number of Lecture Hours		Exam Hours	03
Credits	06		

Course objectives: At the end of the course the student will be able to:
Identify the practical problem, finalize the methodology to solve it and practically implement it.

The duration and modalities for project work will be as per VTU rules and regulations.

Seminar [As per Choice Based Credit System (CBCS) scheme] SEMESTER –VII			
Subject Code	15AUS86	IA Marks	100
Number of Lecture Hours/Week	04	Exam Marks	
Total Number of Lecture Hours		Exam Hours	03
Credits	01		
The topic for seminar should be relevant to the recent developments in Automotive Technology.			

B.E. AUTOMOBILE ENGINEERING

V SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical / Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15AU51	Management and Entrepreneurship	Auto. Engg.	04		03	80	20	100	4
2	15AU52	Dynamics of Machines	Auto. Engg.	04+1T		03	80	20	100	4
3	15AU53	Design of Machine Elements-I	Auto. Engg.	04+ 1T		03	80	20	100	4
4	15AU54	Automotive Fuels and Combustion	Auto. Engg.	04		03	80	20	100	4
5	15AU55X	Professional Elective*	Auto. Engg.	03		03	80	20	100	3
6	15XX56X	Open Elective**	Concerned Branch	03		03	80	20	100	3
7	15AUL57	Automotive Engine Component Lab	Auto. Engg.		1I+2P	03	80	20	100	2
8	15 AUL58	Fluid Mechanics and Fuel Testing Lab	Auto. Engg.		1I+2P	03	80	20	100	2
TOTAL				**24**	**06**		**640**	**160**	**800**	**26**

Professional Elective			**Open Elective**
15 AU551	CAD/CAM	15XX56X	To be published later by VTU
15 AU552	Vehicle Transport Management		
15 AU553	Automotive Air Conditioning and Refrigeration		
15 AU554	Hydraulics and Pneumatics		

***Only one Professional Elective to be chosen.**

**** Students have to select one open Elective as per norms mentioned in list of open electives published by University**

B.E. AUTOMOBILE ENGINEERING

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15AU61	Automotive Chassis & Suspension	Auto. Engg.	04		03	80	20	100	4
2	15AU62	Heat and Mass transfer	Auto. Engg.	04 +1T		03	80	20	100	4
3	15AU63	Design of Machine Elements-II	Auto. Engg.	04+ 1T		03	80	20	100	4
4	15AU64	Automotive Transmission	Auto. Engg.	04		03	80	20	100	4
5	15AU65X	Professional Elective	Auto. Engg.	03		03	80	20	100	3
6	15XX66X	Open Elective	Concerned branch	03		03	80	20	100	3
7	15AUL67	Automotive Chassis Components Lab	Auto. Engg.		1I+2P	03	80	20	100	2
8	15 AUL68	Engine Testing and Emission Measurement Lab.	Auto. Engg.		1I+2P	03	80	20	100	2
TOTAL				**24**	**06**		**640**	**160**	**800**	**26**

Professional Elective		**Open Elective**	
15 AU651	Robotics	15XX66X	To be published later by VTU
15 AU652	Experimental Stress analysis		
15 AU653	Composite Materials		
15 AU654	Automotive Pollution and Control		

***Only one Professional Elective to be chosen.**

**** Students have to selectone open Elective as per norms mentioned in list of open elective published by University**

B.E. AUTOMOBILE ENGINEERING

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	Theory / Practical Marks	I.A. Marks	Total Marks	
1	15AU71	Automotive Electrical and Electronic Systems	Auto. Engg.	04		03	80	20	100	4
2	15AU72	Automotive Engine Components Design and Auxiliary Systems	Auto. Engg	04		03	80	20	100	4
3	15AU73	Finite Element Modeling and Analysis	Auto. Engg	04		03	80	20	100	4
4	15AU74X	Professional Elective	Auto. Engg	03		03	80	20	100	3
5	15AU75X	Professional Elective	Auto. Engg	03		03	80	20	100	3
6	15AUL76	Automobile Scanning and Re-conditioning lab	Auto. Engg		1I+2P	03	80	20	100	2
7	15AUL77	Modeling and Analysis Lab	Auto. Engg		1I+2P	03	80	20	100	2
8	15 AUP78	Project Phase- I + Project seminar	Auto. Engg	---	03	---	---	100	100	2
TOTAL				**18**	**09**		**560**	**240**	**800**	**24**

Professional Elective		**Professional Elective**	
15 AU741	Earthmoving Equipment & Tractors	15 AU751	Control Engineering
15 AU742	Computer Integrated Manufacturing	15 AU752	Engineering Economy
15 AU743	Tribology	15 AU753	Operations Research
15 AU744	Engineering system Design	15 AU754	Two and Three wheeled Vehicle

B.E. AUTOMOBILE ENGINEERING

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15AU81	Vehicle Body Engineering and Safety	Auto. Engg.	04		03	80	20	100	4
2	15AU82	Mechanical Vibrations	Auto. Engg	04		03	80	20	100	4
3	15AU83X	Professional Elective	Auto. Engg.	03		03	80	20	100	3
4	15AU84	Internship/Professional Practice	Auto. Engg	Industry Oriented		03	50	50	100	2
5	15AUP85	Project work Phase II	Auto. Engg.		6	03	100	100	200	6
6	15AUS86	Seminar*	Auto. Engg		4			100	100	1
TOTAL				**11**	**10**		**390**	**310**	**700**	**20**

Professional Elective	
15 AU831	Total Quality Management
15 AU832	Database Management systems
15 AU833	Advanced I.C. Engines
15 AU834	Maintenance Engineering

***Seminar on current trends in Automotive Engineering**