B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES
(Common to all Programmes)

Course Code	**18MAT31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	**03**	Exam Hours	03

Course Learning Objectives:

- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE's arising in engineering applications, using numerical methods.

Module-1

Laplace Transforms: Definition and Laplace transform of elementary functions. Laplace transforms of Periodic functions and unit-step function – problems.
Inverse Laplace Transforms: Inverse Laplace transform - problems, Convolution theorem to find the inverse Laplace transform (without proof) and problems, solution of linear differential equations using Laplace transform.

Module-2

Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis, examples from engineering field.

Module-3

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Simple problems.
Difference Equations and Z-Transforms: Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transform. Simple problems.

Module-4

Numerical Solutions of Ordinary Differential Equations (ODE's): Numerical solution of ODE's of first order and first degree- Taylor's series method, Modified Euler's method. Range - Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector method (No derivations of formulae), Problems.

Module-5

Numerical Solution of Second Order ODE's: Runge -Kutta method and Milne's predictor and corrector method.(No derivations of formulae).
Calculus of Variations: Variation of function and functional, variational problems, Euler's equation, Geodesics, hanging chain, problems.

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

- CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- CO4: Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- CO5:Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.

- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2016
2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition, 2016
Reference Books				
1	Advanced Engineering Mathematics	C. Ray Wylie, Louis C. Barrett	McGraw-Hill Book Co	6th Edition, 1995
2	Introductory Methods of Numerical Analysis	S. S. Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B.V. Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	2014
5	Advanced Engineering Mathematics	Chandrika Prasad and Reena Garg	Khanna Publishing,	2018

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

ENGINEERING THERMODYNAMICS

Course Code	**18 AU32**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To define work, heat, and laws of thermodynamics, entropy, principle and working of refrigeration, jet propulsion.
- To evaluate thermal performance of refrigeration cycles.
- To calculation of efficiency of gas power and vapor power cycles.
- To analyse gas power cycles

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.

Module-2

Laws of Thermodynamics :
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 with and without heat transfer.
Keivin –Planck &Clasius statement of Second law of Thermodynamics, PMM II and PMM I. Clasius Theorem & thermodynamic equivalence of the two statements; reversible and irreversible processes; factors that make a

Module-3

Entropy: Entropy; definition, a property, principle of increase of entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy.

Pure Substances:
P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat).Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams, steam tables and its use, Throttling calorimeter, separating and throttling calorimeter.

Module-4

Refrigeration:
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.

Psychrometry:
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.

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.

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

- Define work, heat, and laws of thermodynamics, entropy, principle and working of refrigeration, jet propulsion
- To evaluate thermal performance of refrigeration cycles.
- To calculation of efficiency of gas power and vapor power cycles.
- To analyse gas power cycles.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Engineering Thermodynamics	P. K. Nag,	Tata McGraw Hill Pub.	2002
2	Applied Thermodynamics	B. K. Venkanna	PHI New Delhi	2011
Reference Books				
3	Thermodynamics, An engineering approach	Yunus, A. Cenegal and Michael A.Boies,	Tata Mac- Graw Hill Publishing Company	2002
4	Fundamental of Classical Thermodynamics-	G. J. Van Wylen and R. E. Sontang,.	Wiley eastern	1994

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SEMESTER - III

MATERIAL SCIENCE AND METALLURGY

Course Code	18AU33	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits :	03	Exam Hours	03

Course Learning Objectives:
At the end of this course, students will be able to:

- Explain different crystal structures, mechanism of various types of failure, types of heat treatment processes, types and methods of manufacturing of composites.
- Draw stress strain diagram for various metals, TTT curves and Iron carbon diagrams
- Select various non-ferrous metals and alloys based on composition and properties for a given application.
- Interpret the phase diagrams.

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 Behaviour:
Stress-strain diagram for ductile and brittle materials, True stress and true strain, linear and non-linear elastic behaviour 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.

Module-2

Fracture: Type I, Type II and Type III.
Creep: Description of the creep phenomenon with examples, three stages of creep, creep properties, stress relaxation.
Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, 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)

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.

Module-5

Non Ferrous Metals: Copper alloys-brasses and bronzes, Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys, composition, properties, advantages and disadvantages and applications.
Composite Materials: Definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP' and MMC's advantages and application of composites.

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

- Explain different crystal structures, mechanism of various types of failure, types of heat treatment processes and types and methods of manufacturing of composites.
- Draw stress strain diagram for various metals, TTT curves and Iron carbon diagrams
- Select various non-ferrous metals and alloys based on composition and properties for a given application.

- Interpret the phase diagrams.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Foundations of Materials Science and Engineering	Smith,	McGraw Hill, 2009	3rd Edition
2	Materials Science	Shackleford. & M. K. Muralidhara,	Pearson Publication	2007.
Reference Books				
3	An introduction to Metallurgy	Alan Cottrell	University Press India Oriental Longman Pvt. Ltd.,	1974.
4	Materials Science and	V. Raghavan,	PHI	2002
5	Materials Science and Engineering	William D. Callister Jr.	John Wiley & Sons. Inc	5th Edition, 2001.

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SEMESTER - III

MECHANICS OF MATERIALS

Course Code	**18AU34**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Explain the basic concepts of stress, strain, behaviour of engineering materials under different loading conditions.
- Calculate principal stresses using analytical and graphical methods, shear force and bending moments, deflection and slop of beams, critical loads for different type of columns using euler's and rankine's equations
- plot shear force and bending moment diagrams for beams carrying different types of loads, and various support conditions
- Determine deflection and slope of beams subjected to various type of loads
- Compare solid and hollow shafts subjected to torque.

Module-1

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.

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.

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 support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.

Stresses 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).

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.

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.

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

- Explain the basic concepts of stress, strain, behaviour of engineering materials under different loading conditions.
- Calculate principal stresses using analytical and graphical methods, shear force and bending moments, deflection and slop of beams, critical loads for different type of columns using euler's and rankine's equations.
- plot shear force and bending moment diagrams for beams carrying different types of loads, and various support conditions.
- Determine deflection and slope of beams subjected to various type of loads.

- Compare solid and hollow shafts subjected to torque.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Strength of Materials	James M Gere, Barry J .Goodno,	Cengage Learning,	2009
2	Strength of Materials	S. S. Bhavikatti	Vikas publications House -1 Pvt. Ltd.	2006
Reference Books				
3	Strength of Materials-	S. S. Rattan, ,	Tata McGraw Hill	2009
4	Mechanics of Materials	K.V. Rao, G.C. Raju,	Suhas stores, Bangalore	2007
5	Strength of Materials	R Subramanian,	Oxford	2005

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SEMESTER - III

MECHANICAL MEASUREMENT AND METROLOGY

Course Code	**18AU35**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- explain significance of mechanical measurements, elements of a generalized measuring system, theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure and strain
- Define Metrology, appreciate the objectives of Metrology, and explain the importance of standards.
- interpret the limits specified, identify fits and explain the concept of tolerance
- Use comparators, screw and gear metrology

Module-1

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)

Module-2

Comparators: 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.

Angular Measurementsand Interferometer:

Bevel protractor. Sine principle, use of sine bars, sine centre, angle gauges (numerical on building of angles), Clinometers. Principle of inter-ferometry, autocollimator, optical flats.

Module-3

Transducers, Intermediate Modifying and Display Devices: Transfer efficiency, primary and secondary transducers, Mechanical, electrical transducers (resistive capacitive and piezoelectric transducers), electronic transducers, advantages of each type of transducers. Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, mechanical signal transmission, . Mechanical, digital read out devices, ultra-violet recorders, servo-recorders cathode ray oscilloscope, Oscillographs, X-Y plotters

Module-4

Measurement of Force,Torque and strain : Principle, analytical balance, platform balance proving ring, torque measurement, types of dynamometers prony brake, Hydraulic dynamometer, Eddy current dynamometer. Strain gauge, preparation and mounting of strain gauges, gauge factor, Methods of strain measurement.

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.

Pressure and Temperature Measurement: Principle, use of elastic members, bridge man gauge, Mcleod 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.

Course Outcomes:

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

- explain significance of mechanical measurements, elements of a generalized measuring system, theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure and strain

- Define Metrology, appreciate the objectives of Metrology, and explain the importance of standards.
- Interpret the limits specified, identify fits and explain the concept of tolerance.
- Use comparators, screw and gear metrology

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Engineering Metrology.	R. K. Jain	Khanna Publishers, New Delhi	2007
2	Mechanical Measurements and Control	D. S. Kumar	Metropolitan Book Co. Pvt. Ltd, New Delhi	2005
Reference Books				
3	Hand book of Industrial Metrology	ASTME	PHI	4^{th} edition
4	Engineering Metrology	K. J. Hume	Kalyani publishers	Third (metric) Edition

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SEMESTER - III

MANUFACTURING PROCESS - I

Course Code	**18AU36**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Define various terms associated with casting processes
- Explain methods of construction of moulds.
- Select moulding machine and moulding process based on material type
- Select appropriate joining process, type of joints.
- Explain different non-destructive testing methods

Module-1

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 moulding sand.
Additives: Need, Types of additives used. Types of base sand, requirement of base sand. Moulding 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 moulding.
Gates & Risers. Principle and types.
Fettling and cleaning of castings: Basic steps, Casting defects, Causes, features and remedies.

Module-2

Special Moulding Process & Furnaces:
Moulding Machines: Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger.
Process: Study of important moulding processes, No bake moulds, Flaskless moulds, Sweep mould, CO2 mould, Shell mould, Investment mould.
Metal moulds: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, and Thixocasting processes.
Furnaces: Constructional features & working principle of coke fired, oil fired and Gas fired pit furnace, Resistance furnace, Electric Arc Furnace, Cupola furnace.

Module-3

Welding Process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Welding defects – Detection causes & remedy.
Arc Welding: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW). 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.
Gas Welding: Principle, Oxy – Acetylene welding, Chemical Reaction in Gas welding, Flame characteristics. Gas torch construction &working. Forward and backward welding.

Module-4

Resistance welding: Principles, Seam welding, Butt welding, Spot welding and projection welding.
Other welding processes: Working principle, advantages and disadvantages and applications of Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes. (AHW) Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.

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.

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

- Define various terms associated with casting processes
- Explain methods of construction of moulds, different non-destructive testing methods.
- Select moulding machine and moulding process based on material type
- Select appropriate joining process and type of joints.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Manufacturing Process	Dr. K. Radhakrishna	Sapna Book House	5th Revised Edition 2009
2	Manufacturing & Technology: Foundry, Forming and Welding	P. N. Rao,	Tata McGraw Hill	2nd Ed, 2003
Reference Books				
3	Manufacturing Technology	Serope Kalpak jain, Steuen. R. Sechmid	Pearson Education Asia,	5th Ed. 2006
4	Process and Materials of Manufacturing	Roy A Lindberg	Pearson Edu.	4th Ed 2006.

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SEMESTER - III

METALLOGRAPHY AND MATERIAL TESTING LABORATORY

Course Code	**18AUL37**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- Conduct experiments in Metallography and Material Testing Laboratory using the principles of material science and mechanics of materials
- Use different material testing machines
- Tabulate the data, plot the graphs and make thorough analysis of results

Sl. No.	Experiments
1	**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. 2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat treated samples. 3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters. 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 5. Brinell, Rockwell and Vickers's Hardness test.
2	**PART- B** 1. Tensile, Shear and Compression tests of metallic and non-metallic specimens using Universal Testing Machine 2. Torsion Test 3. Bending Test on metallic and nonmetallic specimens. 4. Izod and Charpy Tests on M.S, and CI specimen. 5. Fatigue Test.

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

- Conduct experiments in Metallography and Material Testing Laboratory using the principles of material science and mechanics of materials
- Use different material testing machines
- Tabulate the data, plot the graphs and make thorough analysis of results

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50marks and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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SEMESTER - III

FOUNDRY AND FORGING LABORATORY

Course Code	**18AUL38**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

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

Sl. No.	Experiments
1	**PART- A** **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. (Demonstration only)) d. Sieve Analysis to find Grain Finest number of Base Sand e. Clay content determination in Base Sand
2	**PART- B** **Foundry Practice:** a. Use of foundry tools and other equipment. b. Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate) c. Preparation of one casting (Aluminum or cast iron-Demonstration only)
3	**PART- C** a. Calculation of length of the raw material required to prepare the model by forging. b. Preparing minimum three forged models involving upsetting, drawingand bending operations.

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

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

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from part A and part B or part C from lot prepared by examiners.
4. Max. Marks for part A and part B or part C should be 30, 50 marks and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV

Aadalitha Kannada

Course Code	**18KAK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಆಡಳಿತ ಕನ್ನಡದ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ. ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಪರಿವಿಡಿ (ಪಠ್ಯಪುಸ್ತಕದಲ್ಲಿರುವ ವಿಷಯಗಳ ಪಟ್ಟಿ)

ಅಧ್ಯಾಯ – 1 ಕನ್ನಡಭಾಷೆ – ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ.

ಅಧ್ಯಾಯ – 2 ಭಾಷಾ ಪ್ರಯೋಗದಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ.

ಅಧ್ಯಾಯ – 3 ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ.

ಅಧ್ಯಾಯ – 4 ಪತ್ರ ವ್ಯವಹಾರ.

ಅಧ್ಯಾಯ – 5 ಆಡಳಿತ ಪತ್ರಗಳು.

ಅಧ್ಯಾಯ – 6 ಸರ್ಕಾರದ ಆದೇಶ ಪತ್ರಗಳು.

ಅಧ್ಯಾಯ – 7 ಸಂಕ್ಷಿಪ್ತ ಪ್ರಬಂಧ ರಚನೆ (ಪ್ರಿಸೈಸ್ ರೈಟಿಂಗ್), ಪ್ರಬಂಧ ಮತ್ತು ಭಾಷಾಂತರ.

ಅಧ್ಯಾಯ – 8 ಕನ್ನಡ ಶಬ್ದಸಂಗ್ರಹ.

ಅಧ್ಯಾಯ – 9 ಕಂಪ್ಯೂಟರ್ ಹಾಗೂ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನ.

ಅಧ್ಯಾಯ – 10 ಪಾರಿಭಾಷಿಕ ಆಡಳಿತ ಕನ್ನಡ ಪದಗಳು ಮತ್ತು ತಾಂತ್ರಿಕ/ ಕಂಪ್ಯೂಟರ್ ಪಾರಿಭಾಷಿಕ ಪದಗಳು.

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಫಲಿತಾಂಶಗಳು:

- ಆಡಳಿತ ಭಾಷೆ ಕನ್ನಡದ ಪರಿಚಯವಾಗುತ್ತದೆ.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳು ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಖಇ **(ಅಚಿಣಟಿಣಚಿಣ ಖಟಿಣಜಡಿಟಿಚಿಟ ಇತಿಚಿಟಣಚಿಣಟಿ):**

ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II & III/IV

Vyavaharika Kannada

Course Code	**18KVK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate in Kannada language.

Table of Contents:

Course Outcomes:

At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಭಇ **(ಅಡಟಿಣಟಿಣಠಾ ಖಟಿಣಜಡಿಟಿಚಿಟ ಇತಚಿಟಣಚಿಣಠಟಿ):**

ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

ಖಿಷಾಛಾಜಾ (ಪಠ್ಯಪುಸ್ತಕ): ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ ಪಠ್ಯ ಪುಸ್ತಕ (ಗಿಥಿಚಿತಚಿಟಿಚಿಡಿಜಾಚಿ ಏಚಿಟಿಟಿಚಿಜಚಿ ಖಿಷಾ ಃಛಾ)

ಸಂಪಾದಕರು

ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ

ಪ್ರೊ. ವಿ. ಕೇಶವಮೂರ್ತಿ

ಪ್ರಕಟಣೆ : ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ.

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)

Course Code	**18CPC39/49**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Course Learning Objectives: To

- know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

Module-1

Introduction to Indian Constitution: The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

Module-2

Union Executive and State Executive: Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.

Module-3

Elections, Amendments and Emergency Provisions: Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.

Constitutional special provisions: Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Module-4

Professional / Engineering Ethics: Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institutionof Engineers (India): Profession, Professionalism, and ProfessionalResponsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering

Module-5

Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

Course Outcomes: On completion of this course, students will be able to,

- CO1: Have constitutional knowledge and legal literacy.
- CO2: Understand Engineering and Professional ethics and responsibilities of Engineers.
- CO3: Understand the the cybercrimes and cyber laws for cyber safety measures.

Question paper pattern for SEE and CIE:

- The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Constitution of India, Professional Ethics and Human Rights	Shubham Singles, Charles E. Haries, and et al	Cengage Learning India	2018
2	Cyber Security and Cyber Laws	Alfred Basta and et al	Cengage Learning India	2018
Reference Books				
3	Introduction to the Constitution of India	Durga Das Basu	Prentice –Hall,	2008.
4	Engineering Ethics	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Prentice –Hall,	2004

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

ADDITIONAL MATHEMATICS – I

(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B.Tech. programmes)

Course Code	**18MATDIP31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:1:0)	SEE Marks	60
Credits	0	Exam Hours	03

Course Learning Objectives:

- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE's.

Module-1

Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).
Vector Algebra: Scalar and vectors. Addition and subtraction and multiplication of vectors- Dot and Cross products, problems.

Module-2

Differential Calculus: Review of elementary differential calculus. Polar curves –angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's series expansions, problems.
Partial Differentiation: Euler's theorem for homogeneous functions of two variables. Total derivatives - differentiation of composite function. Application to Jacobians of order two.

Module-3

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.

Module-4

Integral Calculus: Review of elementary integral calculus. Statement of reduction formulae for $\sin^n x, \cos^n x, and \sin^m x \times \cos^n x$and evaluation of these with standard limits-Examples. Double and triple integrals, problems.

Module-5

Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: Variable Separable methods, exact and linear differential equations of order one. Application to Newton's law of cooling.

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

- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions. CO4: Learn techniques of integration including the evaluation of double and triple integrals.
- CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015

Reference Books				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10^{th} Edition, 2015
2	Engineering Mathematics Vol.I	RohitKhurana	Cengage Learning	2015

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS
(Common to all programmes)
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**18MAT41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

Module-1

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.
Construction of analytic functions: Milne-Thomson method-Problems.

Module-2

Conformal transformations: Introduction. Discussion of transformations:$w = Z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0)$.Bilinear transformations- Problems.
Complex integration: Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems.

Module-3

Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

Module-4

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.
Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form-
$y = ax + b, y = ax^b and y = ax^2 + bx + c.$

Module-5

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.
Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

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

- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.

- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition,2016
2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition,2016
Reference Books				
1	Advanced Engineering Mathematics	C. Ray Wylie, Louis C.Barrett	McGraw-Hill	6th Edition 1995
2	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	2014

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

B.E.AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

FLUID MECHANICS

Course Code	**18AU42**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: To

- Define fluid properties; describe Pascal's law, Hydrostatic law.
- Calculate total pressure given point and between sections of pipe, Buoyancy and Stability of floating objects.
  Apply Bernoulli's principle to solve fluid flow problems.
- Make dimensional analysis of fluid mechanics problems.
- Analyze various forces acting on submerged bodies.

Module-1

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.

Module-2

Buoyancy: Buoyancy, center of buoyancy, meta centre and meta-centric height, conditions of equilibrium of floating and submerged bodies, determination of Meta-centric 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.

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, orifice meter, pitot-tube, vertical orifice, V-Notch and rectangular notches.

Module-4

Dimensional analysis: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude, types of similtude.
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.

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.

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

- Define fluid properties; describe Pascal's law, Hydrostatic law.
- Calculate pressure given point and difference in pressure between sections of pipe, Buoyancy and Stability of floating objects.
- Apply Bernoulli's principle to solve fluid flow problems.
- Make dimensional analysis of fluid mechanics problems.
- Analyze various forces acting on submerged bodies.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Fluid Mechanics	Pijush. K. Kundu	ELSEVIER	3rd Ed. 2005.
2	Fluid Mechanics	Bansal, R. K.	Lakshmi Publications	2004.
Reference Books				
3	Fluid Mechanics and hydraulics	Dr. Jagadishlal,	Metropolitan Book Co-Ltd.	1997.
4	Fluid Mechanics (SI Units)	Yunus A. Cengel John M.Cimbala	TMH	2006.
5	Fluid Mechanics and Fluid Power Engineering	Kumar. D. S.	Kataria and Sons	2004.

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – IV

KINEMATICS OF MACHINES

Course Code	**18AU43**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Define and explain the basic terms such as kinematic chain, kinematic pair, degree of freedom etc. associated with kinematics of machinery, inversions of four bar mechanism, single slider crank mechanism and double slider crank mechanism.
- Determine the mobility of given mechanisms.
- Determine the velocity and acceleration of links using graphical as well as analytical methods.
- Plot cam profiles using displacement diagram for various types of motions.
- Define gear terminology and determine the velocity ratio in different gear trains.

Module-1

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. 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.

Module-2

Velocity and acceleration analysis of mechanisms: Velocity and acceleration analysis of Four Bar mechanism, 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.

Module-3

Velocity analysis by Instantaneous Method: Kennedy's Theorem, Determination of linear and angular velocity using instantaneous centre method.

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 Kleins's construction.

Module-4

Gears: 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.

Gear Trains: 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.

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.

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

- Define and explain the basic terms such as kinematic chain, kinematic pair, degree of freedom etc. associated with kinematics of machinery, inversions of four bar mechanism, single slider crank mechanism and double slider crank mechanism.
- Determine the mobility of given mechanisms.
- Determine the velocity and acceleration of links using graphical ansanalytical methods.

- Plot cam profiles using displacement diagram for various types of motions.
- Define gear terminology and determine the velocity ratio in different gear trains.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Theory of Machines	Rattan S. S.	Tata McGraw-Hill Publishing Company Ltd., New Delhi	3rd edition -2009
2	Theory of Machines	Sadhu Singh	Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi	2006
Reference Books				
3	Theory of Machines & Mechanisms-	J. J. Uicker, , G.R. Pennock, J. E. Shigley	OXFORD 3rd Ed.	2009

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

AUTOMOTIVE ENGINES

Course Code	**18AU44**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain need, constructional details and working of various auxiliary system used for internal combustion engine, scavenging systems for two stroke engines
- Calculate efficiency of theoretical , fuel air and actual cycles
- Choose cooling and lubrication system for internal combustion engine
- Analyse effect of supercharging and turbocharging on engine performance.

Module-1

Construction and Operation: Engine classification, Constructional details of four stroke spark ignition (SI) and compression ignition (CI) engines. Working principles. Comparison of SI and CI engines , theoretical and actual valve timing diagrams for engines.
Engine Cycles: theoretical Otto, diesel and dual cycles, Fuel-air Cycles and Actual cycle, numericals.

Module-2

Construction of engine parts: Cylinder, cylinder head, piston, piston pin, connecting rod, crank shaft, inlet and exhaust valves, flywheel, valve operating mechanisms**,**
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.

Module-3

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.
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.

Module-4

Supercharging and Turbo charging: 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.

Module-5

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

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

- Explain need, constructional details and working of various auxiliary system used for internal combustion engine, scavenging systems for two stroke engines
- Calculate efficiency of theoretical , fuel air and actual cycles
- Choose cooling and lubrication system for internal combustion engine
- Analyse effect of supercharging and turbocharging on engine performance

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Internal Combustion Engines,	V. Ganesan	Tata McGraw Hill	2007
2	Internal Combustion Engines	Ramalingam K. K.	Sci-Tech Publications	2005
Reference Books				
3	Internal Combustion Engines	Mathur and Sharma	Dhanpat Rai and Sons	2002
4	Fundamentals of Internal Combustion Engines	John B. Heywood.	McGraw Hill International Edition	1998
5	A course in I. C. Engines	Mathur& Sharma	Dhanpat Rai& sons, New Delhi	1994

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SEMESTER - IV

MANUFACTURING PROCESS -II

Course Code	**18AU45**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: 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
  construction and working of various systems in a Lathe, Shaper, Planning and Drilling machine
- Classify grinding and milling machines and explain their construction
- Explain the principle of broaching
- Select non-traditional machining process for given application.

Module-1

Theory Of Metal Cutting & Cutting Tool Materials: 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 work piece and chip. Measurement of tool tip temperature.

Module-2

Turing, Shaping and Planning: Classification of Lathe, constructional features of Turret and Capstan Lathe. Tool Layout, Different operations on lathe, machining.
Classification of Shaping Machine, Planning Machine, shaping and planning machines, construction and working principle of planning and shaping machine. Machining time calculation on above machining

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 (Centre-less, cylindrical and surface grinding). Selection of grinding wheel. Grinding process parameters. Dressing and truing of grinding wheels.

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.

Module-5

Non-Traditional Machining Processes: Need for non-traditional 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.

Course Outcomes:

At the end of the course the student will be able 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.
  construction and working of various systems in a Lathe, Shaper, Planeing and Drilling machine.
- Classify grinding and milling machines and explain their construction.
- Explain the principles of broaching.
- Select non-traditional machining process for given application.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Workshop Technology	Hazara Choudhry	Media Promoters & Publishers Pvt. Ltd.	Vol-II, 2004
2	Production Technology	R. K. Jain	Khanna Publications	2003.
Reference Books				
3	Manufacturing Science	Amitabh Ghosh and Mallik	affiliated East West Press	2003
4	Fundamentals of Metal Machining and Machine Tools	G. Boothroyd	McGraw Hill	2000
5	Production Technology	HMT	Tata MacGraw Hill	2001

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

COMPUTER AIDED MACHINE DRAWING

Course Code	**18AU46**	CIE Marks	40
TeachingHours/Week (L:T:P)	(1:0:4)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Use tools of drafting and modelling software
- Draw the sections of solids, orthographic views of simple machine parts using software
- Sketch and explain various thread forms and their application.
- Calculate parameters related to riveted joints and sketch them.
- Create solid models and draw the sectional views of automotive systems.

PART-A

Module-1

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.

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, set screws, grub screws.

PART B

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 snap head rivets).

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.

PART - C

Module-5

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

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

- Use tools of drafting and modeling software
- Draw the sections of solids, orthographic views of simple machine parts using software
- Sketch and explain various thread forms and their application.
- Calculate parameters related to riveted joints and sketch them.
- Prepare assembly drawing from the list of components.

- Create solid models and draw the sectional views of automotive systems.

Internal assessment: 40 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: 1x20 = 20Marks

PART-B: 1x20 = 20Marks

PART-C: 1x60 = 60 Marks

Total = 100 Marks

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Machine Drawing	K. R. Gopala Krishna	Subhash Publication.	
2	A Primer on Computer Aided Machine Drawing		Published by VTU	
Reference Books				
3	A Text Book of Computer Aided Machine Drawing	S. Trymbaka Murthy	CBS Publishers, New Delhi	2007
4	Machine Drawing with Auto CAD	Goutam Purohit & Goutham Ghosh	1st Indian print Pearson Education,	2005
5	Machine Drawing	N. Siddeshwar, P. Kanniah, V. V. S. Sastri	Tata McGrawHill,	2006

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SEMESTER – IV

MECHANICAL MEASUREMENT AND METROLOGY LAB

Course Code	**18AUL47**	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2: 2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: To

- Identify the measuring instrument and demonstrate its usage
- Calibrate pressure sensor, thermocouple, LVDT and load cell
- Explain the usage of slip gauges for calibration of verniercaliper, height gauge and micrometer
- Determine the form tolerance (cylindricity and circularity)
- Determine thread and gear parameters using standard tests

Sl. No.	Experiments
1	**PART A** 1. Calibration of Pressure Gauge (Bourdon tube pressure gauge) 2. Calibration of Thermocouple 3. Calibration of LVDT 4. Calibration of Load cell **5.** Determination of modulus of elasticity of a mild steel specimen using Strain gauges. **6.** Speed measurement-using Stroboscope
2	**PART B** 1. Calibration of Micrometer, Vernier caliper, Height gauge using slip gauges 2. Measurements using Optical Projector / Toolmaker Microscope. 3. Measurement of Angle using Sine Center / Sine bar / bevel protractor 4. Measurement of Cylindricity and Circularity of Automobile Components 5. Measurement of Straightness and Flatness 6. Calibration of Bore gauge, inside micrometer and component measurement 7. Measurement of Screw threads parameters using Two wire or Three-wire method 8. Measurements of Surface roughness using Tally Surf/Mechanical Comparator **9.** Measurement of gear tooth profile using Gear Tooth Vernier/Gear Tooth Micrometer. **10.** Measurement using Optical Flats

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

- Identify the measuring instrument and demonstrate its usage
- Calibrate pressure sensor, thermocouple, LVDT and load cell
- Explain the usage of slip gauges for calibration of verniercaliper, height gauge and micrometer
- Determine the form tolerance (cylindricity and circularity)
- Determine thread and gear parameters using standard tests

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks respectively and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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SEMESTER – IV

MACHINE SHOP

Course Code	**18AUL48**	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:
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 and shaper and grinding.

Sl. No	Experiments
1	**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.
2	**PART –B** Cutting of V- Groove/ Dovetail / Rectangular groove using a shaper, Cutting of Gear Teeth using Milling Machine.

Course Outcomes: At the end of the course the student will be able 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 and shaper and grinding.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks respectivelyand for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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SEMESTER - IV

ADDITIONAL MATHEMATICS – II

(Mandatory Learning Course: Common to All Branches)

(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech programmes)

Course Code	**18MATDIP41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:1:0)	SEE Marks	60
Credits	00	Exam Hours	03

Course Learning Objectives:

- To provide essential concepts of linear algebra, second & higher order differential equations along with methods to solve them.
- To provide an insight into elementary probability theory and numerical methods.

Module-1

Linear Algebra: Introduction - rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Problems.

Module-2

Numerical Methods: Finite differences. Interpolation/extrapolation using Newton's forward and backward difference formulae (Statements only)-problems. Solution of polynomial and transcendental equations – Newton-Raphson and Regula-Falsi methods (only formulae)- Illustrative examples. Numerical integration: Simpson's one third rule and Weddle's rule (without proof) Problems.

Module-3

Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators.[Particular Integral restricted to $R(x) = e^{ax}, \frac{sinax}{cosax}, x^n \; for \; f(D)y = R(x)$.

Module-4

Partial Differential Equations (PDE's): Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Module-5

Probability: Introduction. Sample space and events. Axioms of probability. Addition & multiplication theorems. Conditional probability, Bayes's theorem, problems.

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

- Solve systems of linear equations using matrix algebra.
- Apply the knowledge of numerical methods in modelling and solving of engineering problems.
- Apply the knowledge of numerical methods in modelling and solving of engineering problems.
- Classify partial differential equations and solve them by exact methods.
- Apply elementary probability theory and solve related problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	43rd Edition, 2015

Reference Books				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10^{th} Edition, 2015
2	Engineering Mathematics Vol. I	Rohit Khurana	Cengage Learning	2015.

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

MANAGEMENT AND ENTREPRENEURSHIP

Course Code	**18AU51**	CIE Marks	40
TeachingHours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain management functions of a manager. Also explain planning and decision making processes, organizational structure, staffing and leadership processes, understanding of motivation and different control systems in management.
- Identify various types of supporting agencies and financing available for an entrepreneur.
- Prepare project report and decide selection of industrial ownership.

Module-1

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.

Module-2

Organizing and Staffing: Nature and purpose of organization, Principles of organization – Types of organization-Departmentation Committees-Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of staffing :Process of Selection & Recruitment (in brief).

Controlling: Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

Directing: Meaning and nature of directing Leadership styles, Motivation, Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of coordination.

Module-3

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.

Module-4

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 Single Window Agency; SISI; NSIC; SIDBI; KSFC.

Module-5

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.

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

- Explain management functions of a manager. Also explain planning and decision making processes, organizational structure, staffing and leadership processes, understanding of motivation and different control systems in management.
- Identify various types of supporting agencies and financing available for an entrepreneur.
- Prepare project report and decide industrial ownership.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Principles of Management	P. C. Tripathi, P.N. Reddy	Tata McGraw Hill.	6th edition, 2017
2	Dynamics of Entrepreneurial Development & Management	Vasant Desai	Himalaya Publishing House.	6th edition, 2018
3	Entrepreneurship Development	Poornima. M. Charantimath	Small Business Enterprises -Pearson Education	2006
Reference Books				
1	Management Fundamentals Concepts, Application, Skill Development	Robers Lusier, Thomson.	South western cangage learning USA	2012
2	Entrepreneurship Development	S. S. Khanka	S. Chand & Co. New Delhi.	2015

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

DYNAMICS OF MACHINES

Course Code	**18AU52**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- Calculate static and dynamic forces at various points in different types of mechanism, flywheel dimensions.
- Determine and take corrective action on imbalance due to rotating masses and reciprocating masses.
- Find controlling force in various governors.
- Describe fluctuation of energy in flywheel, various types of governors and to understand method of finding.
- Analyse gyroscopic effect on aeroplane and automobiles stability.
- Analyze cams for follower motions.

Module-1

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].

Module-2

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.

Module-3

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.

Module-4

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.

Module-5

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.

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

- Calculate static and dynamic forces at various points in different types of mechanism, flywheel

dimensions.

- Determine and take corrective action on imbalance due to rotating masses and reciprocating masses.
- Find controlling force in various governors.
- Describe fluctuation of energy in flywheel, various types of governors and to understand method of finding.
- Analyse gyroscopic effect on aeroplane and automobiles stability.
- Draw cam profiles for different follower motions.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Theory of Machines	Rattan S. S.	Tata McGraw Hill Publishing Company Ltd	2012
2	Theory of Machines	Sadhu Singh	Pearson Publications, New Delhi	2000
Reference Books				
3	Theory of Machines and Mechanisms	Joseph E. Shigley, Jr. Uicker John	McGraw Hill publications	1998
4	Dynamics of Machinery	A. R. Holowenko	John Wiley & sons.	2000
5	Theory of Machines	R. S. Khurmi and J. K. Gupt	S. Chand and Co	2015

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

DESIGN OF MACHINE ELEMENTS - I

Course Code	**18AU53**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- Define and explain basic terms related to the design of machine elements.
- Design various machine elements.

Module-1

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, Distortion energy theory.

Module-2

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 of inertia.

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.

Module-3

Design of Simple Machine Elements: Design of Knuckle joints. Keys: Types of keys, Design of keys, Couplings, types of couplings, design of flange type of rigid coupling.

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

Module-4

Riveted Joints: Introduction, methods of riveting, Types of rivets, rivet materials, types of riveted joints, 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).

Module-5

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.

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

- Define and explain basic terms related to the design of machine elements.
- Design various machine elements

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				

1	Design of Machine Elements	V. B. Bhandari	Tata McGraw Hill Publishing Company Ltd New Delhi	2nd Edition 2007
2	Mechanical Engineering Design	Joseph E shigley and Charles R. G. Budynas	McGraw hill international	edition- 6 , 2009.
3	Design Data Hand Book	K. Lingaiah	McGraw Hill	2nd Ed.2003
4	Design Data Hand Book	K. Mahadevan and Balaveera Reddy	CBS Publication.	2001
Reference Books				
3	Theory and problems of Machine Design (Schaum's Outlines series),	Hall, Holowenko,	Tata McGraw Hill Publishing Company Ltd., New Delhi.	2014
4	Machine design-I	J. B. K. Das Laughlin	Sapna Book House, Bangalore	2010

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

AUTOMOTIVE FUELS AND COMBUSTION

Course Code	**18AU54**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Explain available energy sources for internal combustion engine.
- Determine correct A/F ratio for a given fuel.
- Explain stages of combustion in S.I. & C.I. engines.
- Design SI & CI engine combustion chambers.
- Explain and differentiate between multi fuel and duel fuel engines.

Module-1

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.

Module-2

I. C. Engine 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, CNG, Alcohols, Biodiesels, Gaseous Fuel Injections, Dual Fueling and Controls – CNG and Gasoline, Hydrogen and Diesel, Alcohols and Diesels etc.

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-3

Combustion in S. I. Engines:

Initiation of combustion, combustion stages, flame velocities, effect of variables on ignition lag and 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.

Module-4

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, and heat balance and related numerical.

Module-5

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.

Course Outcomes:

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

- Explain available energy sources for internal combustion engine.
- Determine correct A/F ratio for a given fuel.
- Explain stages of combustion in S.I. & C.I. engines.
- Design SI & CI engine combustion chambers.
- Explain and differentiate between multi fuel and duel fuel engines.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	I. C. Engines	Mathur& Sharma	Dhanpat Rai& Sons, New Delhi	1994
2	Fuels & Combustion	S. P. Sharma & Chandra Mohan	Tata McGraw-Hill, New Delhi	1987
Reference Books				
3	Internal Combustion Engines	Ganesan, V	Tata McGraw Hill Book Co.,	1995
4	Internal Combustion Engine Fundamentals	John B. Heywood	McGraw Hill Book	1998
5	Internal Combustion Engine and Air Pollution	Obert, E. F.	International Text Book Publishers	1983

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

AUTOMOTIVE TRANSMISSION

Course Code	**18AU55**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain the Constructional, design and working principles of different types of clutches, fluid couplings, torque convertors, different gear box etc..
- Determine the gear ratio, speed of vehicle and number of teeth on driving and driven gears.
- Explain the constructional and principle of operation of different types epicyclic gear box, Calculation of gear ratio for epicyclic gear box.
- Understand necessity, advantages, constructional and principle of operation of different types of automatic transmissions and hydraulic control.

Module-1

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.

Module-2

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.

Module-3

Power Required for Propulsion: The need for transmission,Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration gradeability, drawbar pull, Numerical Problems.

Transmission: Necessity of gear box, Calculation of gear ratios for vehicles, Performance characteristics in different gears , Desirable speed ratios of gear boxes, Constructional details of - Sliding-mesh gear box, Constant-mesh gear box, Synchromesh gear box, auxiliary transmissions, numerical problems.

Module-4

Epicyclic Transmission: Principle of operation, types of planetary transmission, 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.

Module-5

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.

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

- Explain the Constructional, design and working principles of different types of clutches, fluid couplings, torque convertors, different gear box etc..

- Determine the gear ratio, speed of vehicle and number of teeth on driving and driven gears.
- Explain the constructional and principle of operation of different types epicyclic gear box, Calculation of gear ratio for epicyclic gear box.
- Explain the necessity, advantages, constructional and principle of operation of different types of automatic transmissions and hydraulic control.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automotive Mechanics	N.K. Giri	Khanna Publication, New Delhi	2014
2	Advanced Vehicle Technology	Heinz Heisler		2002.
Reference Books				
3	Automotive Transmissions and Power trains	Crouse W.H	McGraw Hill Co. 5thedn,	1976.
4	Motor Vehicle	Newton K and Steeds. W	Butter Worth's & Co. Publishers Ltd,	1997.
5	Automobile Engineering	Kirpal Singh	Standard Pub.	2011.

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SEMESTER - V

HYDRAULICS AND PNEUMATICS

Course Code	**18AU56**	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain basics of Hydraulics and pneumatics.
- Describe Various components of hydraulic system and maintenance of hydraulic system
- Design hydraulic system.
- Describe layout and details of pneumatic systems.

Module-1

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.

Module-2

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.

Module-3

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.

Module-4

Pneumatic Controls: Choice of working medium, characteristics of compressed air,.preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout. 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: 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-5

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.

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

- Introduce basics of Hydraulics and pneumatics.
- Describe Various components of hydraulic system and maintenance of hydraulic system
- Design hydraulic system.
- Describe layout and details of pneumatic systems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Fluid Power with applications	Anthony Esposito	Pearson education, Inc	2000.
2	Pneumatics and Hydraulics	Andrew Parr	Jaico Publishing Co.	2000.
Reference Books				
3	Systems – Principles and Maintenance	S. R. Majumdar,	Tata McGraw Hill publishing company Ltd.	2001
4	Pneumatic systems	S. R. Majumdar	Tata McGraw Hill publishing Co	1995.
5	Industrial Hydraulics	Pippenger Hicks	McGraw Hill, New York.	2001

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SEMESTER - V

AUTOMOTIVE ENGINE COMPONENTS LAB

Course Code	**18AUL57**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: To

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

Sl. No.	**Experiments**
1	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, and 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.
2	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 5. Identification of location of above components in a vehicle and note their functions along with the brand names.

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

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

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks respectively and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be

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SEMESTER - V

FLUID MECHANICS AND FUEL TESTING LAB.

Course Code	**18AUL58**	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: To

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

Sl. No.	Experiments
1	**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.
2	**PART B** 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: At the end of the course the student will be able to:

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

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks respectively and for viva 20 marks.

5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

ENVIRONMENTAL STUDIES

Course Code	**18CIV59**	CIE Marks	40
Teaching Hours / Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Module - 1

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake. 02 Hrs
Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module - 2

Advances in Energy Systems (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind. 02 Hrs
Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Module - 3

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.02 Hrs
Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module - 4

Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module - 5

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs. 03 Hrs
Field work: Visit to anEnvironmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

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

- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
- CO2: Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Question paper pattern:

- The Question paper will have 100 objective questions.
- Each question will be for 01 marks
- Student will have to answer all the questions in an OMR Sheet.

The Duration of Exam will be 2 hours.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

Textbook/s				
1	Environmental Studies	Benny Joseph	Tata Mc Graw – Hill.	2nd Edition, 2012
2.	Environmental Studies	S M Prakash	Pristine Publishing House, Mangalore	3rd Edition, 2018
3	Environmental Studies – From Crisis to Cure	R Rajagopalan	Oxford Publisher	2005
Reference Books				
1	Principals of Environmental Science and Engineering	Raman Sivakumar	Cengage learning, Singapur.	2nd Edition, 2005
2	Environmental Science – working with the Earth	G.Tyler Miller Jr.	Thomson Brooks /Cole,	11th Edition, 2006
3	Text Book ofEnvironmental and Ecology	Pratiba Sing, AnoopSingh& PiyushMalaviya	Acme Learning Pvt. Ltd. New Delhi.	1st Edition

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

AUTOMOTIVE CHASSIS & SUSPENSION

Course Code	**18AU61**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: To

- Explain different chassis layouts and frames, Suspensions, Wheels and Tyres, Propeller Shaft, Differential and Rear Axles, etc.
- Determine stability and weight distribution and suitability of frames.
- Calculate dimensions of major chassis components.
- Describe, about various Front Axles, factors of wheel alignment Steering Systems and Calculate dimensions of Front Axle.
- Compare various types of Brakes and solve numerical.
- Diagnose the troubles of chassis components and suggest remedies.

Module-1

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.

Module-2

Front Axle and Steering Systems: Axle parts and materials, loads and stresses, center sections, section near steering head, spring pads, front axle loads, steering heads, factors of wheel alignment, wheel balancing, center 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.

Module-3

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, 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, numerical problems.

Module-4

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, types of master, wheel cylinder, 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.

Module-5

Suspension system: 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.
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.

Course Outcomes:

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

- Explain different chassis layouts and frames, Suspensions, Wheels and Tyres, Propeller Shaft, Differential and Rear Axles, etc.
- Determine stability and weight distribution and suitability of frames.
- Calculate dimensions of major chassis components.
- Describe, about various Front Axles, factors of wheel alignment Steering Systems and Calculate dimensions of Front Axle.
- Compare various types of Brakes and solve numerical.
- Diagnose the troubles of chassis components and suggest remedies.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automobile Engineering	Kirpal Singh	Standard publications, New Delhi	12th edition Vol. I, 2009.
2	Automotive Mechanics	N. K. Giri	Khanna Publications, New Delhi	2008.
Reference Books				
3	Steering, Suspension and Tyres	Giles. J. G.	Iiiffe Book Co., London	1988.
4	Automotive Chassis	Heldt P. M	Chilton Co., Literary Licensing, LLC,	2012.
5	Automotive chassis and body	P. L. Kohli	TMH.	2002

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

HEAT AND MASS TRANSFER

Course Code	18AU62	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course LearningObjectives : To

- Explain fundamental principles and laws of conduction, convection and radiation modes of heat transfer and mass transfer.
- Analyze all modes of heat transfer and mass transfer under different conditions.
- Calculate heat exchange through heat exchanger.
- Apply laws of radiation heat transfer to solve engineering problems.

Module-1

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 1st, 2nd 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.

Module-2

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.

Module-3

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 horizontal cylinders 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. Numericals.

Module-4

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.

Module-5

Thermal radiation: Definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement 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.

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

- Explain fundamental principles and laws of conduction, convection and radiation modes of heat transfer and mass transfer.
- Analyze all modes of heat transfer and mass transfer under different conditions.
- Calculate heat exchange through heat exchanger.
- Apply laws of radiation heat transfer to solve engineering problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Heat transfer	P. K. Nag,	Tata McGraw Hill, New	2002.
2	Heat transfer-A basic approach	Ozisik,	Tata McGraw Hill	2002.
Reference Books				
1	Heat transfer, a practical	Yunus A,	Tata McGraw Hill.	2001
2	Principles of heat transfer	Kreith	Thomas Learning	2001
3	Heat & Mass transfer	Tirumaleshwar,	Pearson education	2006

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

DESIGN OF MACHINE ELEMENTS-II

Course Code	18AU63	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: To

- Analyze the stresses in the critical section of a curved beam.
- Calculate specifications of springs/gears/clutches.
- Select suitable size, module & type of gears for a required velocity ratio.
- Verify suitability of a type and class of lubricant for a specific application.
- Design various internal combustion engine parts.

Module-1

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 and length of spring leaves.

Clutches & Brakes: Introduction, design of Clutches (single plate, multi plate clutches). Brakes, energy absorbed by a brake, heat dissipated during braking, design of brake shoes.

Module-2

Spur 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 and Bevel Gears: definitions, formative number of teeth, design based on strength, dynamic and wear loads. Terminology used in bevel gears, formative number of teeth, design based on strength, dynamic and wear loads.

Module-3

Sliding Bearings: 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, Principle of 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.

Module-4

Internal combustion engine components design:

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, calculation of major dimensions.

Valve and Valve Mechanism: Number 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, OHV, OHC, dual valves, Valve train component details, Camshaft,-drives of cams, cam types, tappets,-automatic zero clearance tappets, push rods, rocker arms & rocker Shaft, calculation of major dimensions

Module-5

Connecting Rod: Length of rod, Cross section, Buckling, Drilled connecting rods, piston pin bearing, offset connecting rods, effects of whipping, bearing materials and lubrication, calculation of major dimensions.

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, calculation of major dimensions.

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

- Analyze the stresses in the critical section of a curved beam.
- Calculate specifications of springs/gears/clutches.
- Select suitable size, module & type of gears for a required velocity ratio.
- Verify suitability of a type and class of lubricant for a specific application.
- Design various internal combustion engine parts.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	**Design Data Hand Books:** Design Data Hand Book	K. Mahadevan and K. Balaveera Reddy,	CBS, Publication.	4th edition
2	Design Data Hand Book	K. Lingaiah	McGraw Hill,	2nd Ed. 2003.
3	Mechanical Engineering Design	Joseph E Shigley and Charles R.	McGraw Hill Int. edition.	2003
4	Design of Machine Elements	V. B. Bhandari	Tata McGraw Hill Publishing Company Ltd, New Delhi	2nd Edition 2007.
Reference Books				
5	Machine Design- Norton	Robert L.	Pearson Education Asia	2001.
6	Machine Design	Hall, Holowenko, and Laughlin	Tata McGraw Hill Publishing Company Ltd	2010

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

ALTERNATIVE ENERGY SOURCES FOR AUTOMOBILES

Course Code	18**AU**641	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Describe need for alternative fuels for Internal combustion engine and alternative drive systems for automobiles, principle of solar energy collection, construction of photo voltaic cells
- Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
- Explain use of hydrogen for internal combustion engine application.
- Describe use of various gaseous fuels for internal combustion engine application.
- Explain various aspects of electrical and Hybrid vehicles

Module-1

Introduction: Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels and drive trains. Scenario of conventional auto fuels, oil reserves of the world. Fuel quality aspects related to emissions. Technological up gradation required business driving factors for alternative fuels. Implementation barriers for alternative fuels. Stakeholders of alternative fuels, Road map for alternative fuels.

Solar energy: Solar energy geometry, solar radiation measurement devices. Solar energy collectors, types of collectors. Direct application of solar energy, solar energy storage system. P. V. effect solar cells and characteristics. Application of solar energy for automobiles.

Module-2

Biogas: History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas. Production, properties, Engine performance, advantages and disadvantages of Methanol, Ethanol, Butanol, Straight vegetable oil, Biodiesel for internal combustion engine application.

Module-3

Hydrogen: Properties and production of hydrogen, Storage, Advantages and disadvantages of hydrogen, use of Hydrogen in SI and CI engines. Hazards and safety systems for hydrogen, hydrogen combustion. Emission from hydrogen.

Gaseous fuels: Production, properties, Engine performance, advantages and disadvantages of CNG, LNG, ANG, LPG and LFG.

Module-4

Reformulated Conventional Fuels: Introduction. Production of coal water slurry, properties, as an engine fuel, emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline.

Future Alternative Fuels: Production, properties, Engine performance, advantages and disadvantages of PMF, Ammonia, Liquid-Nitrogen, Boron, Compressed Air, Water as fuel for Internal combustion Engine.

Module-5

Alternative Power Trains: 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. History of dual fuel technology, Applications of DFT. Duel fuel engine operation. Advantages and disadvantages of duel fuel technology.

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

- Describe need for alternative fuels for Internal combustion engine and alternative drive systems for automobiles, principle of solar energy collection, construction of photo voltaic cells
- Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
- Explain use of hydrogen for internal combustion engine application.
- Describe use of various gaseous fuels for internal combustion engine application.
- Explain various aspects of electrical and Hybrid vehicles

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Alternative Fuel.	S .S. Thipse	JAICO.Publishing House	2015
2	Non-Conventional Energy Sources	G. D. Rai	Khanna Publishing New Delhi	2010
Reference Books				
3	Alternative fuels guide.	R. Bechtold	SAE	2005
4	Alternative energy sources	T.N Veziroglu	McGraw Hill	2001
5	Automotive Fuels Guide	Richard L. Bechtold	SAE Publications	1997

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SEMESTER - VI

COMPOSITE MATERIALS

Course Code	18AU642	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain basic concepts of composite materials and application of composite material in various engineering fields.
- Describe various FRP processing.
- Describe selection, requirements for production and application of MMC.
- Explain students to various techniques used for MMC production.
- Describe concepts of nano-materials, nano technology and use of nano materials.
- Analyze micro mechanical properties of lamina using various approaches.

Module-1

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.

Module-2

Fibre Reinforced Plastic processing: Layup and curing, fabricating process – open and closed mould process – hand layup techniques – structural laminate bag moulding, production procedures for bag moulding – filament winding, pultrusion, pulforming, thermo – forming, injection, injection moulding, liquid moulding, blow moulding.

Module-3

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 its application, liquid metallurgy technique and its application and secondary processing, special fabrication.

Module-4

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 nano-material using Chemical vapor depositions, physical vapor deposition, phase transformation of nano-particles, magnetic, optical, electrical and mechanical properties of nanoparticles.

Module-5

Micromechanical Analysis of a Lamina: Introduction, evolution of four elastic modulii by strength of material approach, rule of mixture, Numerical.

Mechanics of Lamina: Hooks law for different types of materials, number elastic constants, two dimensional relationship of compliance and stiffness matrix.

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

- Explain basic concepts of composite materials and application of composite material in various engineering fields.
- Describe various FRP processing.
- Decide selection, requirements for production and application of MMC.
- Explain students to various techniques used for MMC production.
- Describe concepts of nano-materials, nano technology and use of nano materials.
- Analyze micro mechanical properties of lamina using various approaches.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Composites- Science and Engineering	K. K. Chawla	Springer Verlag	1998
2	Introduction to composite materials	Hull and Clyne	Cambridge University Press	2nd edition , 1990.
Reference Books				
1	Forming Metal hand book		ASM handbook,	9th edition1988
2	Mechanics of composites	Artar Kaw	CRC Press	2002
3	Composite Materials	S. C. Sharma	Narosa publishing House, New Delhi	2000.

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SEMESTER - VI

AUTOMOTIVE POLLUTION AND CONTROL

Course Code	18AU643	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

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

Module-1

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 and global warming.

Module-2

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, NOx 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.

Module-3

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.

Module-4

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, NOx treatment in Diesel Engines, particulate traps, Diesel Trap oxidizer.

Module-5

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 ionization detectors, Analyzers for NOx, Orsat apparatus, Smoke measurement, comparison method, obscuration method, ringelmann chart, Continuous filter type smoke meter, Bosch smoke meter, Hart ridge smoke meter.

Course Outcomes:

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

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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automobiles and pollution	Paul degobert	(SAE)	2001
2	Internal combustion engine fundamentals	John B. Heywood	McGraw Hill Book publication	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	Engine emissions, Pollutant Formation and Measurement	George, Springer and Donald J.	Patterson, Plenum press,.	1972
4	Internal Combustion Engines and Air Pollution	Obert, E. F	Intext Educational Publishers	1980.

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

OPEN ELECTIVE - A

AUTOMOBILE ENGINEERING

Course Code	18AU651	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Explain construction and working of internal combustion engine, working of different fuel systems, etc,
- Calculate gear ratios for given power transmission.
- Describe emissions of pollutants from internal combustion engines and methods of controlling.
- Compare electrical and Electronic ignition system.

Module-1

Engine Components and Auxiliary Systems: Spark Ignition(SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S. I. Engine and C. I. Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements.

Module-2

Fuels, Fuel Supply Systems For SI and CI Engines: Conventional fuels, alternative fuels, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors.

Module-3

Ignition Systems: Battery Ignition systems, Magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems.

Power Trains: General arrangement of clutch, Principle of friction clutches, Constructional details, Single plate and multi-plate. Gear box: Necessity for gear ratios in transmission, synchromesh gear boxes, planetary gears, over drives, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches.

Module-4

Drive to Wheels: Propeller shaft and universal joints, differential, rear axle, , steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, steering gears, power steering, general arrangements of links and stub axle, types of chassis frames.

Module-5

Suspension, Springs and Brakes: Requirements, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical and hydraulic braking systems, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system.

Automotive Emission Control Systems: Sources of emission from engines, Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Exhaust gas recirculation, Catalytic converter, Emission standards- Euro I, II, III and IV norms, Bharat Stage norms

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

- Explain construction and working of internal combustion engine, working of different fuel systems, etc,
- Calculate gear ratios for given power transmission.
- Describe emissions of pollutants from internal combustion engines and methods of controlling.

- Compare electrical and Electronic ignition system

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automotive Mechanics	William H Crouse & Donald L	Tata McGraw Hill Publishing Company Ltd.	10th Edition, 2007
2	Automotive Engineering	R. B. Gupta,	Satya Prakashan, New Delhi	4th edn.1984
Reference Books				
3	Automotive mechanics: Principles and Practices	Joseph Heitner	D Van Nostrand Company, Inc	2001
4	Fundamentals of Automobile Engineering	K. K. Ramalingam	Scitech Publications (India) Pvt. Ltd.	2007
5	Automobile Mechanics	Srinivasan	Tata McGraw Hill.	2003

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SEMESTER - VI

OPEN ELECTIVE - A

VEHICLE TRANSPORT MANAGEMENT

Course Code	18AU652	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: to

- Explain infrastructure required for Fleet operation and maintenance.
- Understand organizational structure and importance and methods of route planning.
- Analyze different methods of fare collection systems.
- Calculate fleet operating costs.
- Formulate different methods of accident prevention.

Module-1

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.

Module-2

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.

Module-3

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.

Module-4

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.

Module-5

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.

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

- Explain construction and working of internal combustion engine, working of different fuel systems, etc,
- Calculate gear ratios for given power transmission.
- Describe emissions of pollutants from internal combustion engines and methods of controlling.
- Compare electrical and Electronic ignition system

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Bus operation	L. D. Kitchen	Iliffe&Sons , London	. 1992
2	Bus & coach operation	Rex W. Faulks	Butterworth London.	1987
Reference Books				
3	M. V. Act 1988		Central Law Agency,	1995
4	Compendium of transport terms -		CIRT, Pune	2001

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

OPEN ELECTIVE - A

NON TRADITIONAL MACHINING

Course Code	18AU653	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Discuss the difference between conventional and non conventional machining process.
- Characterize the USM and AJM with the effect of parameters and process characteristics
- Explain the working principle ECM and CHM with the effect of parameters and process characteristics.
- Discuss about the working principle of EDM with the effect of parameters and process characteristics
- Describe the working principle PAM and LBM with the effect of parameters and process characteristics.

Module-1

Introduction: Need for non-traditional machining, History, Classification, comparison between conventional and Non-conventional machining process selection.

Ultra Sonic Machining (USM): Introduction, equipment, cutting tool system design, Effect of various parameters on USM process characteristics: Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.

Module-2

Abrasive Jet Machining (AJM): Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean No. abrasive particles per unit volume of the carrier gas, work material, standoff distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM.

Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.

Electron Beam Machining (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM.

Module-3

Electrochemical Machining (ECM): Introduction, study of ECM machine, elements of ECM process classification of ECM process: Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Process characteristics - Material removal rate, Accuracy, surface finish, ECM Tooling: ECM tooling technique & example, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug, Economics of ECM, Applications such as Electrochemical turning, Electrochemical Grinding, Electrochemical Honing, de-burring, Advantages, Limitations.

Chemical Machining (CHM): Introduction, elements of process, chemical blanking process: Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps –masking, Etching, process characteristics of CHM: material removal rate accuracy, surface finish, Hydrogen embrittlement.

Module-4

Electrical Discharge Machining (EDM): Introduction, machine, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode manufacture, Electrode wear , EDM tool design choice of machining operation electrode material selection, under sizing and length of electrode , machining time. Flushing pressure flushing suction flushing, side flushing, pulsed flushing synchronized with electrode movement, EDM process characteristics: metal removal rate, accuracy surface finish, Heat affected Zone. Machine tool selection, Application EDM, electrical discharge grinding, Traveling wire EDM.

Module-5

Plasma Arc Machining (PAM): Introduction, equipment non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.

Laser Beam Machining (LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

Course Outcomes:

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

- Discuss the difference between conventional and non conventional machining process.
- Characterize the USM and AJM with the effect of parameters and process characteristics
- Explain the working principle ECM and CHM with the effect of parameters and process characteristics.
- Discuss about the working principle of EDM with the effect of parameters and process characteristics
- Describe the working principle PAM and LBM with the effect of parameters and process characteristics.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Modern Machining Process	Pandey and Shah	Tata McGraw Hill	2000
2	Production Technology	HMT	TATA McGraw Hill.	2001
Reference Books				
3	Modern Machining Process	P. K. Mishra	The Institution of Engineers (India) Test book series, Narosa Publishing House	2005.
4	Metals Handbook: Machining(Hardcover)	Joseph R. Davis (Editor)	American Society of Metals (ASM)	volume 16

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

AUTOMOTIVE CHASSIS COMPONENTS LAB

Course Code	18AUL66	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2:2)	SEEMarks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

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

Sl. NO	Experiments
	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 Outcomes: At the end of the course the student will be able to:

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

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

ENGINE TESTING AND EMISSION MEASUREMENT LAB

Course Code	18AUL67	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2:2)	SEEMarks	60
Credits	02	Exam Hours	03

Course Learning Objectives: To

- Determine performance characteristics of various types of engines.
- Determine finding FP, IP, BP of multi Cylinder engines by conducting Morse test.
- Verify suitability of various alternative fuels for internal combustion engines.
- Conduct emission tests on various engines.

Sl. No.	Experiments
	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 Outcomes: At the end of the course the student will be able to:

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

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER -VI

MINI PROJECT

Course Code	18AUMP68	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:0:2)	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course Learning Objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

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

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates. ■

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University. ■

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

INTERNSHIP

All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VIand VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail and shall have to complete during subsequent University examinations after satisfying the internship requirements.

Course Code	Refer to VIII semester scheme	CIE Marks	40
Duration of internship	04 weeks	SEE Marks	60
Credit	02	Exam Hours/ Batch	03

Course Learning Objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.

Internship: Students under the guidance ofinternal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course Outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learntto classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.

Continuous Internal Evaluation

CIE marks for the Internshipshall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as

the Chairman.
The CIE marks awarded shall be based on the evaluation of Internship Report, Presentation skill and Question and Answer session in the ratio 50:25:25.■

Semester End Examination

SEE marks for the Internship shall be awarded based on the evaluation of Internship Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.■

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

FINITE ELEMENT MODELLING AND ANALYSIS

Course Code	18AU71	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

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

Module-1

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 minimum potential energy, Raleigh's Ritz method.

Module-2

Basic Procedure: Direct approach for stiffness matrix formulation of bar element. Galerkin's method.

Discretization of 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.

Module-3

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.

Module-4

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 element. Hermiteshape function of beam element.

Module-5

Beams: Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.

Heat Transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction. Galerkin's approach for heat conduction. 1D heat transfer in thin fins.

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

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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Finite Elements in Engineering	T. R. Chandrupatla, A. D. Belegunde	PHI.	3rd Ed
2	Finite Element Method in Engineering	S. S. Rao	4th Edition, Elsevier,	2006.
Reference Books				
3	Finite Element Methods for Engineers	U. S. Dixit	Cengage Learning	2009
4	Concepts and applications of Finite Element Analysis	R. D. Cook, D. S Maltus, M.E Plesha, R. J. Witt	John Wiley and sons	4th Ed, 2009
5	Finite Element Method	J. N. Reddy	McGraw -Hill	International Edition

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS

Course Code	18AU72	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain the construction of battery used in automotive vehicles.
- Describe the construction and working of D.C. generator, alternator, cranking motor, ignition systems along with trouble shooting.
- Discuss the faults arising in automotive wiring and lighting system.
- Design layout of electrical systems.
- Use transducers and sensors in electronic circuits.
- Explain various aspects of electrical and Hybrid vehicles.

Module-1

Introduction: Earth return and insulated systems, 6 volts 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.

Module-2

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.

Module-3

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 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-4

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.

Module-5

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.

Transducers and Sensors: Definition and classification, principle of working and application of various light

sensors, proximity sensors and Hall effect sensors. Introduction to internet of things (IOT) and its application.

Course Outcomes:

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

- Explain the construction of battery used in automotive vehicles.
- Describe the construction and working of D.C. generator, alternator, cranking motor, ignition systems along with trouble shooting.
- Discuss the faults arising in automotive wiring and lighting system.
- Design layout of electrical systems.
- Use transducers and sensors in electronic circuits.
- Explain various aspects of electrical and Hybrid vehicles.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automobile Electrical and Electronic systems	Tom Denton	SAE publication.	2000
2	Automotive Electrical Equipment	P. M. Kohli,	Tata McGraw Hill, New Delhi	1983
Reference Books				
3	Advanced Engine Technology	Heinz Heisler	SAE Publications.	1995
4	Automotive Electronic Systems	Ulrich Adler, Robert Bosch	GMBH	1995
5	Mechatronics	W. Bolton	Longman, 2Ed, Pearson publications	2007

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

CAD/CAM

Course Code	18AU731	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Describe the fundamental theory and concepts of the CAD/CAM, basic hardware structure and components used in CAD systems, principles of Computer Aided Designing systems and the concepts of Geometric Modeling, solid modeling, feature-based design modelling, concepts of NC and CNC programming and machining, concepts of FEA.
- Develop transformations for 2D geometric modelling
- 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.
- Apply both practices (manually and CAM) to develop the G-code program.

Module-1

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.

Module-2

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.

Module-3

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 of CNC, CNC machining centers, CNC turning centers, high speed CNC machine tools.

Module-4

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, highnspeed machine tools.

Module-5

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 of robots, end effectors work cell, control and interlock, robot sensor, robot applications.

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

- Describe the fundamental theory and concepts of the CAD/CAM, basic hardware structure and components used in CAD systems, principles of Computer Aided Designing systems and the concepts of Geometric Modeling, solid modeling, feature-based design modelling, concepts of NC and CNC programming and machining, concepts of FEA.
- Develop transformations for 2D geometric modelling
- 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.
- Apply both practices (manually and CAM) to develop the G-code program.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	CAD/CAM Principles and Application	P. N. Rao	Tata McGraw Hill.	2010
2	CAD/CAM	Groover	Tata McGraw Hill, New Delhi	2000
Reference Books				
3	Principles of Interactive Computer Graphics,	Newman and Sproull	Tata McGraw Hill	1995.
4	NC Machine Programming and Software Design	Chno-H Wachang, Michel. A.	Melkan off, Prentice Hall,	1989.
5	CAD/CAM	Ibrahim Zeid	Tata McGraw Hill	1999.

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

EARTHMOVING EQUIPMENT & TRACTORS

Course Code	18AU732	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Explain about various basic operations and applications of earth moving equipment.
- Select under carriage, hydraulics, steering systems of tractors.
- Select suitable machine for hauling depending on type of land, haul distance, climate, etc.

Module-1

Equipment and Operation: Different types, working principles and applications of bull Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments.

Module-2

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.

Module-3

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.

Module-4

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.

Module-5

Criterion 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.

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

- Explain about various basic operations and applications of earth moving equipment.
- Select under carriage, hydraulics, steering systems of tractors.
- Select suitable hauling machine depending on type of land, haul distance, climate, etc.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				

1	Diesel equipment	Erich J.schulz	PHI	volume I and II
2	Construction equipment and its management	S. C. Sharma	McGraw Hill	2002
Reference Books				
3	Theory of ground vehicles	J. Y. Wong	john Wiley and sons	1999
4	On and with the earth	Jagman Singh	W. Newman and Co. Kalkata	2005

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

COMPUTER INTEGRATED MANUFACTURING

Course Code	18AU733	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain need for computer integrated manufacturing.
- Calculate WIP, TIP ratios using mathematical modeling.
- Analyze Automated Flow line & Line balancing.
- Analyze AGV's.
- Develop part programming for milling and turning processes.
- Programme the robots for given application.

Module-1

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.

Module-2

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.

Module-3

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 Multi station Assembly machine analysis of single station assembly.

Automated Guided Vehicle System: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's with numerical problems and application.

Module-4

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.

Module-5

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.

Course Outcomes:

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

- Explain need for computer integrated manufacturing.
- Calculate WIP, TIP ratios using mathematical modelling.
- Explain various drives and mechanisms used in CIM.
- Analyze Automated Flow line & Line balancing.
- Analyze AGV's.
- Develop part programming for milling and turning processes.
- Programme the robots for given application.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automation, Production system & Computer Integrated	M.P. Grover	Person India,	2007
2	Principles of Computer Integrated Manufacturing	S. Kant Vajpayee	Prentice Hall India	2001
Reference Books				
3	Fundamentals of Robotics - Analysis and Control	Schilling R. J.	PHI	2006.
4	Introduction to Robotics - Mechanical and Control	Craig, J. J.	Addison-Welsey	2nd Edition1989.

B. E. AUTOMOBILE ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

CONTROL ENGINEERING

Course Code	18AU741	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

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

Module-1

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.

Module-2

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.

Module-3

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.

Module-4

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.

Module-5

Root Locus Plots: Definition of root loci, General rules for constructing root loci, 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.

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

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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Modern Control Engineering	Katsuhiko	Pearson Education	2004
2	Systems Principles and Design	- M. Gopal	TMH	3rd Ed., 2000.
Reference Books				
3	Modern Control Systems 3. Feedback Control System - Schaum's series. 2001.	Richard. C. Dorf and Robert. H. Bishop	Addison Wesley	1999
4	System Dynamics & Control	Eronini, Umez,	Thomson Asia Pvt. Ltd. Singapore.	2002

B. E. AUTOMOBILE ENGINEERING
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SEMESTER - VII

OPERATIONS RESEARCH

Course Code	18AU742	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

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

Module-1

Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method.

Solution of Linear Programming Problems: The simplex method canonical and standard form of an LP problem, slack, surplus and artificial variables, big M method and concept of duality, dual simplex method.

Module-2

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases.

Assignment Problem: Formulation, types, application to maximization cases and travelling salesman problem.

Module-3

Integer Programming: Pure and mixed integer programming problems, solution of Integer programming problems-Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero- One programming.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models – M/M/1 and M/M/C models and their steady state performance analysis.

Module-4

PERT-CPM Techniques: Introduction, network construction – rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.

Module-5

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.

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

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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Operations Research	P. K. Gupta and D S Hira	S. Chand Publications, New Delhi	2007
2	Operations Research	S. D. Sharma,	LedarnathRamanath& Co.	2002.
Reference Books				
3	Operations Research	A. P. Verma	S K Kataria& Sons	2008
4	Operations Research	A. M. Natarajan, P Balasubramani,	Pearson Education	2005.
5	Introduction to Operations Research	Hillier and Liberman,	McGraw Hill.	8th Ed.

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SEMESTER - VII

TWO AND THREE WHEELED VEHICLE

Course Code	18AU743	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles, types of clutches, transmission and final drives used for two and three wheeled vehicles..
- Lay down wiring diagram for two wheeler and three wheeled vehicles, maintenance schedule for two and three wheeled vehicles.
- Describe types of frames, brakes and tyres used for two and three wheeled vehicles.

Module-1

Introduction: History and layouts of mopeds, scooters, motor cycles, , classification of two wheelers, basic systems of two wheelers,

Two wheeler dynamics: Linear and angular motion, handling characteristics, road holding, vehicle stability and aerodynamics, performance measurement.

Module-2

Fuel, Lubrication And Cooling System: Layout of fuel supply system, fuel tank construction, carburettor 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.

Module-3

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.

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, and lubrication.

Final Drive: Introduction to motorcycle final drives, Fundamentals of chain drive, Chain lubrication and lubricators, Shaft drives, Drive shaft couplings, Final drive gear case.

Module-4

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.

Module-5

Three Wheelers: Classification of three wheelers, layout of passenger three wheeler, load carriers, types of commercial three wheeled vehicles, Drive train of passengers and commercial three wheelers, suspension and brakes of three wheelers

Maintenance: Importance of maintenance, Decarburizing procedure for engine and silencer, periodic inspection, maintenance schedules, trouble diagnosis charts, safety precautions, Lubrication charts.

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

- Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles, types of clutches, transmission and final drives used for two and three wheeled vehicles..
- Lay down wiring diagram for two wheeler and three wheeled vehicles, maintenance schedule for two and three wheeled vehicles.
- Describe types of frames, brakes and tyres used for two and three wheeled vehicles.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Two and three wheeler technology	Dhruv U. Panchal	PHI	2015
2	Motor cycle Mechanics	William H. Crouse and Donald L.	TMH	2001
Reference Books				
3	The cycle Motor manual	---	Temple Press Ltd,	1990
4	Encyclopaedia of Motor Cycling	Marshall Cavendish	New York.	1989.

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SEMESTER - VII

OPEN ELECTIVE - B

ENGINEERING ECONOMICS AND COST ESTIMATION

Course Code	18AU751	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Explain method to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives, .
- Calculate payback period and capitalized cost on one or more economic alternatives.
- Carryout breakeven analyses on one or more economic alternatives
- Discuss Preparation of cost estimation report for any project.
- Analyse the replacement policy. .

Module-1

Introduction: Definition of various economic terms such as economic goods, utility, value, price, wealth, wants capital, rent and profit, Laws of returns

Demand and supply & wages: Law of diminishing utility and total utility. Demand Schedule, Law of demand. Elasticity of demand, Law of substitution, Law of supply, supply schedule, elasticity of supply. Nominal and real wages, Factors affecting real wages, theory of wages, Difference in wages, methods of wage payment

Module-2

Money and Exchange: Theory of exchange, Barter, stock exchange, Speculation money qualities of a good money, function of a money, classification of money, value of money, index number, appreciation and depreciation of money value, Gresham's Law and its limitations

Taxation and Insurance:

Principle of taxation, characteristics of a good taxation system, kinds of taxes, and their merits and demerits, Vehicle Insurance, Loss Assessment.

Module-3

Interest and Depreciation: Introduction, theory of interest, interest rate, interest from lender's and borrower's view point, simple and compound interest. Nominal and effective interest rates, interest formulae annual compounding, annual payments and continuous compounding annual payment, simplenumerical problems. Need for depreciation, causes of depreciation life and salvage value methods of depreciation, simple numerical problems.

Module-4

Costs: Standard costs estimated cost, First cost, Fixed cost, Variable costs, Incremental cost, Differential cost, Sunk and marginal cost, Breakeven and minimum cost analysis, simple numerical problems.

Cost Accounting: Introduction, objectives of cost accounting, elements of cost material cost, labour cost, and expenses, allocation of overheads by different methods, simple numerical problems.

Module-5

Book Keeping and Accounts: Introduction, Necessity of book keeping, single entry and double entry system, Classification of assets, Journal, Ledger, Trial balance, Final accounts, trading, profit and loss account, Balance sheet, Numerical

Cost Estimation: Introduction, importance, objectives and functions of estimating, principle factors in estimating, Functions and qualities of an estimator, estimating procedure. Estimation of material cost and manufacturing cost of simple automotive components, Estimation of cost of overhauling and servicing of automotive components - cylinder, valves, valve seats, crankshaft, FIP, Brake drum, body building, different types of repairs.

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

- Explain method to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives, .
- Calculate payback period and capitalized cost on one or more economic alternatives.
- Carryout breakeven analyses on one or more economic alternatives
- Discuss Preparation of cost estimation report for any project.
- Analyse the replacement policy. .

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Engineering Economics, ,	Tara Chand	Nem Chand and Brothers, Roorkee	1995
2	Engineering Economy	Thuesen, G. J. and Fabrycky, W. J.	Prentice Hall of India Pvt. Ltd.	2001
Reference Books				
3	Industrial Organization and Engineering Economics,	T. R. Banga and S. C. Sharma	Khanna Publishers, New Delhi	2003
4	Mechanical Estimating and Costing	T. R. Banga and S. C. Sharma	Khanna Publishers, Delhi	2007
5	Mechanical Estimating and Costing	D. Kannappan et al	Tata McGraw Hill Publishing Company Ltd	2003

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Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –VII
Open Elective - B

TOTAL QUALITY MANAGEMENT

Course Code	18AU752	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

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

Module-1

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.

Module-2

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,

Module-3

Quality Management 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.

Module-4

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.

Module-5

Statistical Process Control:
Paratodigram, process flow diagram, fishbone diagram, histograms, check sheets, statistical fundamentals. Control charts, types of control charts, scattered diagrams case studies and numerical problems.

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

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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Total Quality Management	Dale H. Bester field	Pearson Education India	Edition 03
2	The management and control of Quality	James R. Evans and William M. Lindsay	Thomson South-Western	Edition-6
Reference Books				
3	100 Methods for Total Quality Management	Gopal K. Kanji and Mike Asher	Sage Publications, Inc	Edition – 1
4	Total Quality Management for Engineers -,	M. Zairi	Wood head Publishing.	ISBN: 1855730243

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SEMESTER - VII

OPEN ELECTIVE - B

NON- DESTRUCTIVE TESTING

Course Code	18AU753	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

- Explain Principles of selection of non destructive Evaluation method (NDE)
- Use various inspection methods like Magnetic particle, Radiographic Inspection their Principle, general procedure, advantages and limitations
- Verification of proper assembly and Inspect for in-service damage.

Module-1

Selection of NDE methods: Flaw detection & evaluation, leak detection & evaluation, metrology & evaluation, structure / microstructure characterization, visual inspection.
Replication microscopy techniques for NDE
Specimen preparation, replication techniques, and micro structural analysis.
Liquid Penetrant Inspection: Principles penetrate methods, procedure, materials used, equipment, parameters, and applications.

Module-2

Magnetic Particle Inspection: Principle, general procedure, advantages & limitation, applications, magnetic field generation, magnetic hysteresis, magnetic particles & suspending liquid
Radiographic inspection: Principles, X-ray radiography, equipment, Gamma - Ray radiography, real time radiography & film radiography, application examples.

Module-3

Computed Tomography (CT): Principles, capabilities, comparison to other NDE methods, CT equipment, and industrial computed tomography applications.
Thermal Inspection: Principles, equipment, inspection methods applications.

Module-4

Optical Holography: Basics of Holography, recording and reconstruction-info metric techniques of inspection, procedures of inspection, typical applications. Acoustical Holography: systems and techniques applications.
Eddy Current Inspection: Principles of operation, procedure, advantages & limitations, operating variables, inspection.

Module-5

Ultrasonic Inspection: Principles basic equipment, advantages & limitations, applicability, major variables in ultrasonic inspection, basic inspection methods- pulse echo method, transducers and couplants.
Acoustic Emission Inspection: Principles comparison with other NDE methods, applicability, Acoustic emission waves & propagation, instrumentation principles.

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

- Explain Principles of selection of non destructive Evaluation method (NDE)
- Use various inspection methods like Magnetic particle, Radiographic Inspection their Principle, general procedure, advantages and limitations
- Verification of proper assembly and Inspect for in-service damage.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Metals hand book, Nondestructive evaluation & quality control		American society of metals.	Vol-17,9th Edition
2	Non-destructive testing.		American Society for Non-destructive testing.	Vol. 5
Reference Books				
3	Non-destructive Evolution and quality control	Metals Hand Book	Asia international	9 edition , 1989
4	the Testing instruction of Engineering materials	Davis H. E Troxel G. E	McGraw Hill.	2001

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SEMESTER - VII

AUTOMOBILE SCANNING AND RE-CONDITIONING LAB

COURSE CODE	18AUL76	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2:2)	SEEMarks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- Check and adjust ignition timing and tappet clearance
- Align the given connecting rod
- Reboring of given engine cylinders
- Service the FIP and calibrate
- Battery testing and charging

Sl.NO	Experiments
1	**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. Cylinder reboring machine c. Valve refacing machine d. Nozzle grinding machine. e. Brake drum skimming machine f. General servicing of two wheeler
2	**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. Battery testing and charging 5. Head light focusing test and visibility test.

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

- Check and adjust ignition timing and tappet clearance
- Align the given connecting rod
- Rebore the given engine cylinders
- Service the FIP and calibrate
- Battery testing and charging

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero

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SEMESTER - VII

MODELING AND ANALYSIS LAB

Course Code	18AUL77	CIE Marks	40
TeachingHours/Week (L:T:P)	(0:2:2)	SEEMarks	60
Credits	02	Exam Hours	03

Course Learning Objectives: to

- Explain procedure for FEA
- Model and analyze bar, beam and trusses subjected to various types of loads
- Analyze heat transfer and flow processes

Sl. No.	Experiments
1	PART- A Study of FEA packages, Modelling, 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.
2	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 Outcomes: At the end of the course the student will be able to:

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

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from each part from lot prepared by examiners.
4. Max. Marks for part A and B should be 30, 50 marks and for viva 20 marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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SEMESTER -VII

PROJECT WORK PHASE - 1

Course Code	18AUP78	CIE Marks	100
TeachingHours/Week (L:T:P)	(0:0:2)	SEE Marks	--
Credits	01	Exam Hours/Batch	--

Course Learning Objectives: To

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course Outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

CIE procedure for Project Work Phase - 1:

(i)Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.■

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SEMESTER -VIII

VEHICLE BODY ENGINEERING AND SAFETY

Course Code	18AU81	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: to

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

Module-1

Classification of Coachwork: Styling forms, coach and bus body style, layout of cars, buses and coach with different seating and loading capacity, types of commercial vehicles, vans and pickups, etc. 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.

Module-2

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.

Module-3

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.

Module-4

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 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-5

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, energy absorbent foams, laws of mechanisms applied to safety.

Course Outcomes:

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

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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Vehicle body engineering	Giles J Pawlowsky	Business books limited	1989
2	Vehicle body layout and analysis	John Fenton	Mechanical Engg. Publication ltd, London.	1990
Reference Books				
3	Hand book on vehicle body design		SAE publication.	
4	Automotive chassis	P.M. Heldt	Chilton & Co	1970
5	Vehicle Safety 2002		Cornwell press Town bridge, UK	ISBN 1356 - 1448
6	Aerodynamics of Road Vehicles	W.H.	Butter worth's 1987	4th Edition

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SEMESTER -VIII

MECHANICAL VIBRATIONS

Course Code	18AU821	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To

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

Module-1

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.
Un-damped 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.

Module-2

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.

Module-3

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.

Module-4

Two degree of freedom systems: Introduction, principle and normal modes of vibration, co-ordinate coupling, 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-5

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.

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

- Classify different types of vibration / damping associated with systems and vibration measuring instruments.
- Calculate natural frequency, damping, logarithmic decrement and other parameters of single degree of freedom un-damped / damped free vibrating systems
- Compute the response of single degree of freedom damped vibrating systems to different excitation forces.

- Determine the natural frequencies and the modes of two degree of freedom free vibrating systems.
- Compare the natural frequencies / modes of multi-degree of freedom free vibrating systems using numerical methods

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Mechanical Vibrations	G. K. Grover and S. P. Nigam	Nemchand and Brothers, Roorkee.	2009
2	Mechanical Vibrations	V. P. Singh	Dhanpat Rai and Sons, New Delhi	2001
Reference Books				
3	Theory and Problems of Mechanical Vibrations	William W. Seto	McGraw Hill International Book Co., Singapore	1964
4	Mechanical Vibrations	S. S. Rao	Pearson Education Inc.,	2010
5	Fundamentals of Mechanical Vibrations	S. Graham Kelly	McGraw Hill Publishing Co. Ltd.,	2000

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SEMESTER -VIII

ADVANCED I. C. ENGINES

Course Code	18AU822	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

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

Module-1

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.

Module-2

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.

Module-3

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.

Module-4

Modern Developments in I. C. Engines: Lean burn engines, ceramic and adiabatic engines, Multi-valving, Tuned 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-5

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.

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.

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

- Explain combustion phenomenon in SI and CI Engines, factors effecting combustion variations in these engines
- Calculate mixture requirement and pollutants produced in internal combustion engines.
- Determine efficiency and power output from brayton cycle

- Explain basic concepts of lean burn engine, sterling engine, cam less engine, multi valve engine etc.
- Explain working of modern engines.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Internal Combustion Engines fundamentals	John B. Heywood,	McGraw Hill International Edition	1998
2	A course in I. C. Engines	Mathur& Sharma	DhanpatRai& sons, New Delhi	1994
Reference Books				
3	Internal Combustion Engines	Ganesan, V	Tata McGraw Hill Book Co	1995.
4	Internal Combustion Engine and Air Pollution	Obert, E. F.,	International Text Book Publishers	1983
5	I. C. Engines	Maleev	CBS Publications, New Delhi.	1995

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SEMESTER - VIII

ELECTRIC AND HYBRID VEHICLE.

Course Code	18AU823	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Explain working principle of hybrid vehicle and its main components, operating principle and properties of the most common types of electrical motors in hybrid technology.
- Analyze the performance of a hybrid vehicle.
- Evaluate the environmental impact of road vehicles.

Module-1

Introduction: Performance characteristics of road vehicles, calculation of road load, predicting fuel economy, Grid connected hybrids

DC motors: Series wound, shunt wound. Compound wound and separately excited.

Module-2

AC motors: Induction, synchronous, brushless DC motor, switched reluctance motors.

Hybrid Architecture: Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT). Wheel motor.

Module-3

Hybrid Power Plant specifications: Grade and cruise targets. Launching and boosting, braking and energy recuperation drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.

Module-4

Sizing the Drive System: Matching electric drive and ICE, sizing the propulsion motor, sizing power electronics

Energy Storage Technology: Battery basics, different types of batteries (lead-acid battery / Lithium / Alkaline), High discharge capacitors, flywheels, battery parameters

Module-5

Fuel cells: Fuel cell characteristics, fuel cell types - alkaline fuel cell, proton exchange membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV.

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

- Explain working principle of hybrid vehicle and its main components, operating principle and properties of the most common types of electrical motors in hybrid technology.
- Analyze the performance of a hybrid vehicle.
- Evaluate the environmental impact of road vehicles.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	The Electric Car: Development & Future of Battery, Hybrid &Fuel-Cell Cars	Dr Mike Westbrook, M H Westbrook	British library Cataloguing in Publication Data, UK	ISBN0 85296 0131.

2	Electric and Hybrid Vehicles	Robin Hardy, Iqbal Husain	CRC Press	0-8493-1466-6.
Reference Books				
3	Hand Book of Electric Motors	Hamid A Taliyat, Gerald B Kliman	Mercel Dekker Inc., US	ISBN0-8247-4105-6
4	Propulsion Systems for Hybrid Vehicles	John M. Miller	Institute of Electrical Engineers, London,	ISBN0 863413366.

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SEMESTER -VIII

PROJECT WORK PHASE -II

Course Code	18AUP83	CIE Marks	40
Contact Hours/Week	0:0:2	SEE Marks	60
Credits	08	Exam Hours/Batch	03

Course Learning Objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Project Work Phase - 2:

(i)Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.■

Semester End Examination

SEE marks for the project (60 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) as per the University norms by the examiners appointed VTU.

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SEMESTER -VIII

TECHNICAL SEMINAR

Course Code	18AUS84	CIE Marks	100
Contact Hours/Week	02	SEE Marks	--
Credits	01	Exam Hours	--

Course Learning Objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, shallchoose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.

- Carryout literature survey, organize the seminarcontent in a systematic manner.
- Prepare the report with own sentences, avoiding cut and paste act.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course Outcomes:

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

- Attain, use and develop knowledge in the field of engineering and other disciplines through independent learning and collaborative study.
- Identify, understand and discuss current, real-time issues.
- Improve oral and written communication skills.
- Explore an appreciation of the self in relation to its larger diverse social and academic contexts.
- Apply principles of ethics and respect in interaction with others.■

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks

Presentation skill:25 marks

Question and Answer: 25 marks.■