# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination

and

## Syllabi

## B.E. III-Semester & IV-Semester

## of

## Four Year Degree Programme

## In

## Automobile Engineering

(With effect from the academic year 2017 – 2018)
(As approved in Faculty Meeting held on 26 July 2017)

Issued by

**Dean, Faculty of Engineering**

**Osmania University, Hyderabad**

**July 2017**

## SCHEME OF INSTRUCTION & EXAMINATION
B.E. III - Semester
**(AUTOMOBILE ENGINEERING)**

| S.No | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | Pr/ Drg | Contact Hrs / wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | BS 301 MT | Engineering Mathematics-III | 3 | 1 | - | 4 | 30 | 70 | 3 | 3 |
| 2 | ES 321CE | Mechanics of Materials | 3 | 1 | - | 4 | 30 | 70 | 3 | 3 |
| 3 | ES 323 EE | Automotive Electrical & Electronics Engineering | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | PC 301 AE | Thermal Engineering | 4 | - | - | 4 | 30 | 70 | 3 | 4 |
| 5 | PC 302 AE | Automotive Engineering Drawing | 2 | - | 2 | 4 | 30 | 70 | 3 | 3 |
| 6 | PC 303 AE | Fluid Mechanics & Machinery | 4 | - | - | 4 | 30 | 70 | 3 | 4 |
| **Practical / Laboratory Courses** | | | | | | | | | | |
| 7 | ES 362 EE | Electrical Wiring & Microprocessor Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 8 | PC 351 AE | Fluid Power Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| **Total** | | | **19** | **2** | **6** | **27** | **230** | **520** | | **22** |

BS: Basic Sciences ES: Engineering Sciences MC: Mandatory Course
PC: Professional Course HS: Humanities and Sciences
L: Lectures T: Tutorials Pr : Practicals Drg: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3) Students admitted into B.E./B.Tech. courses under lateral entry scheme (through ECET) from the academic year 2017-18 should undergo the following bridge course subjects at III Semester (CBCS).
(1) ES 154 CS Computer Programming Lab
(2) MC 156 EG Engineering English Lab

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| BS 301 MT | **ENGINEERING MATHEMATICS - III** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | 1 | -- | -- | **30** | **70** | **3** |

**Course Objectives**

- To introduce the concept of functions of complex variables and their properties
- To formulate partial differential equations and to introduce a few methods to solve first order linear and non-linear partial differential equations.
- To study Fourier series and its applications to partial differential equations

**Course Outcomes**

- To determine the analyticity of a complex functions and expand functions as Taylor and Laurent series
- To evaluate complex and real integrals using residue theorem
- To expand function as a Fourier series
- To find solutions of first order and second order partial differential equation

**UNIT-I**

**Functions of Complex Variables**

Limits and continuity of function, differentiability and analyticity, necessary & sufficient conditions for a function to be analytic, Cauchy- Riemann equations in polar form, harmonic functions, complex integration, Cauchy's integral theorem, extension of Cauchy's integral theorem for multiply connected regions, Cauchy's integral formula, Cauchy's formula for derivatives and their applications.

**UNIT-II**

**Residue Calculus**

Power series, Taylor's series, Laurent's series, zeros and singularities, residues, residue theorem, evaluation of real integrals using residue theorem, bilinear transformation, conformal mapping.

**UNIT-III**

**Fourier Series**

Fourier series, Fourier series expansions of even and odd functions, convergence of Fourier series, Fourier half range series.

**UNIT-IV**

**Partial Differential Equations**

Formation of first and second order partial differential equations, solution of first order equations, Lagrange's equation, Nonlinear first order equations, Charpit's method, higher order linear equations with constant coefficients.

**UNIT-V**

**Fourier Series Applications to Partial Differential Equations**

Classification of linear second order partial differential equations, separation of variables method (Fourier method), Fourier series solution of one dimensional heat and wave equations, Laplace's equation.

**Suggested Reading:**

1. R.K.Jain & S.R.K Iyengar, "**Advanced Engineering Mathematics"**, Narosa Publication, 4th Edition, 2014.
2. B.S.Grewal, "**Higher Engineering Mathematics**", Khanna Publications, 43rd Edition, 2014. .
3. Gupta & Kapoor, "**Fundamentals of Mathematical statistics"**, Sultan Chand & Sons, New Delhi, 2014.
4. Erwin Kreyszig, "**Advanced Engineering Mathematics"**, 9th Edition, 2012. 5. James Brown and Ruel Churchill, Complex variables and Applications, 9th Edition, 2013.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| ES 321 CE | **MECHANICS OF MATERIALS** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | 1 | -- | -- | **30** | **70** | **3** |

**Course Objectives**

- To understand the basic concept of stress and strains for different materials
- To know the mechanism of the development of shear force and bending moment in beams
- To know the theory of simple bending, direct & bending stress and distribution of shear stress
- To study the deflections and its applications
- To analyze and understand shear stress, torsional stress and spring applications

**Course Outcomes**

- To understand the theory of elasticity and Hook's law
- Analyze beams to determine shear force and bending moments
- Solve problems on bars and to determine deflections at any point of the beams.
- Analyze and design structural members subjected to combined stresses.

**UNIT – I**

**Simple Stresses and Strains**

Types of stresses and strains. Hook's Law, Stress- Strain curve for ductile materials, moduli of elasticity. Poisson's ratio, linear strain, volumetric strain, relations between elastic constants. Bars of varying sections, bars of uniform strength, compound bars and temperature stresses, change in length.

**UNIT -II**

**Shear Force and Bending Moment**

Relation between intensity of loading, Shear force and bending moment, shear force and bending moment diagrams for cantilever and simply supported beams with and without overhanging for point loads, uniformly distributed loads, uniformly varying loads and couples. Compound Stresses: Stresses on oblique planes, principle stresses and principle planes. Mohr circle of stress and ellipse of stress.

**UNIT -III**

**Theory of Simple Bending**

Assumptions derivation of basic equation: M/I = F/y = E/R Modulus of section, Moment of resistance, determination of flexural stresses. Direct and Bending Stresses: Basic concepts, core of sections for rectangular, solid and hollow circular and I sections. Distribution of shear stress: Equation of shear stress, distribution across rectangular.

**UNIT -IV**

**Deflections**

Deflections of cantilever and simply supported beams including overhanging beams for point loads and uniformly distributed loads by double integration and Macaulay's method.

Strain Energy: Strain energy in bars due to gradually applied loads, sudden loads, impact loads and shock loads.

**UNIT -V**

**Torsion**

Theory of pure torsion- derivation of basic equation T/J = q/R = NΘ/L and hollow circular shafts, strain energy- Transmission of power, combined bending and torsion. Springs: Close and open coiled helical springs subjected to axial loads and axial couples, strain energy in springs- carriage springs.

**Suggested Readings**

1. D.S. Prakash Rao, "**Strength of Materials – A practical Approach"**, Universities Press, 1999.
2. R.K. Rajput, "**Strength of Materials"**, S. Chand & Co., 2003.
3. B.C. Punmia, "**Strength of Materials and Theory of Structures"**, Laxmi Publishers, Delhi, 2000.
4. Ferdinand P Beer et.al., "**Mechanics of Materials"**, Tata McGraw-Hill, 2004.
5. G.H. Ryder, "**Strength of Materials"**, Third Edition in SI units, Macmillan Indian Limited, Delhi,
2002.
6. S. Ramamrutham, "**Strength of Materials"**,, Dhanpat Rai & Sons, 1993.
7. S.S. Bhavakatti, "**Strength of Materials"**, Vikas Publications, 2003.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| ES 323 EE | **AUTOMOTIVE ELECTRICAL & ELECTRONICS ENGINEERING** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | -- | -- | -- | **30** | **70** | **3** |

**Course Objectives**

- To understand the principle and construction of batteries and accessories
- To know the working of different starter drive units and principle of starter motor
- To understand the charging system and the working of its units and generation of direct current
- To know the fundamentals of automotive electronics
- To know working of sensors and activators & microprocessor

**Course Outcomes**

- Explain the principle and construction of batteries and accessories
- Demonstrate the working of different starter drive units and starter motor
- Explain different units of charging system and generation of D.C Current
- Apply electronics for different automobile systems
- Apply different sensors and microprocessors for the measurement of operating parameters of an automobile

**UNIT-I**

**Batteries and Accessories**

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries various tests on batteries, maintenance and charging. Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods – Horn, wiper system and trafficator.

**UNIT-II**

**Starting System**

Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenance of starter motor, starter switches.

**UNIT-III**

**Charging System**

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout, voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects and bridge rectifiers, new developments.

**UNIT-IV**

**Fundamentals of Automotive Electronics**

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

**UNIT-V**

**Sensors and Activators**

Types of sensors: Sensor for speed, throttled position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors relay. Introduction to Microprocessor & Applications in Automobiles.

**Suggested Reading**

1. Young A.P. & Griffiths. L. "**Automotive Electrical Equipment**", ELBS & New Press - 1999.
2. William B. Riddens "**Understanding Automotive Electronics**", 5th edition – Butter worth Heinemann Woburn, 1998.
3. Bechhold "**Understanding Automotive Electronics**", SAE, 1998.
4. Crouse, W.H "**Automobile Electrical Equipment**", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 301 AE | **THERMAL ENGINEERING** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 4 | -- | -- | -- | **30** | **70** | **4** |

**Course Objectives**

- To understand Thermodynamics systems, Thermodynamics properties, energy interactions in the form of work and heat and apply first law of thermodynamics for open and closed systems
- To explain the concept of Second law of Thermodynamics, entropy and Carnot theorem and acquire knowledge about heat engine, heat pump and refrigerator.
- To understand the Brayton cycle and methods to improve its efficiency and also steady flow of gases through nozzles and diffusers
- To understand working of air compressor, study the effect of clearance volume on volumetric efficiency and power required and learn different types of refrigeration systems
- To understand and represent phase change of a pure substance and also acquire the knowledge about fuel cells and hybrid vehicles.

**Course Outcomes**

- Distinguish thermodynamic systems, apply Zeroth law for temperature measurement and find first law of thermodynamics for closed and open systems
- Apply second law of thermodynamics to heat engine, heat pump and refrigerator to find their performance and determine entropy changes for a closed system
- Determine thermal efficiency of Brayton cycle, apply methods to improve thermal efficiency and solve problems related to flow through nozzles and diffusers
- Calculate the power required to run compressor, analyze the effect of clearance volume and multistage compression on volumetric efficiency and work of compression and also demonstrate different types of refrigeration systems
- Demonstrate the phase change of pure substance, evaluate the properties of steam and performance of Rankine Cycle and explain about fuel cells and hybrid vehicles.

**UNIT-I**

**First Law of Thermodynamics**

System, thermodynamic equilibrium, state, property, process, cycle, Zeroth law of thermodynamics, energy, work, heat, first law of thermodynamics, PMM I, ideal gases, application of first law of thermodynamics to closed and open systems, pressure – volume diagrams, steady flow process, application of steady flow energy equation.

**UNIT-II**

**Second Law of Thermodynamics**

Limitations of first law, statements of second law of thermodynamics, PMM II, Clausius inequality, heat engine, heat pump, refrigerator, Carnot cycle, Carnot theorem, entropy, temperature – entropy diagram, entropy changes for a closed system.

**UNIT-III**

**Gas Power Cycles & Fluid Flow**

**Gas Power Cycles:** Air Standard Brayton cycle – Analysis, Classification of gas turbines-Open and closed cycle gas turbines, constant pressure combustion and constant volume combustion gas turbines, calculation of various efficiencies and parameters, Performance Improvement Methods - Intercooling, Reheating and Regeneration.

**Fluid Flow:** One-dimensional steady flow of gases and steam flow through nozzles and diffusers.

**UNIT - IV**

**Properties of Pure Substance & Refrigeration Cycles**

**Properties of Pure Substance:** Concept of phase change, graphical representation on p-v, p-T, T-h and T-s diagrams, properties of steam, Use of steam tables and Mollier diagram. Rankine Cycle – Analysis.

**Refrigeration Cycles:** Fundamentals of Refrigeration, COP, Reversed Carnot cycle, simple vapour compression refrigeration system, T-S, P-H diagrams, simple vapour absorption refrigeration system, desirable properties of an ideal refrigeration.

**UNIT – V**

**Reciprocating Air Compressors, Fuel cells and Hybrid Vehicles**

**Reciprocating Air Compressors**: Single acting and double acting air compressors, work required, effect of clearance volume, volumetric efficiency, isothermal efficiency, free air delivery. Multistage compression, condition for minimum work.

**Fuel Cells:** Types of fuel cells, working principle, Advantages of fuel cells, Current state of the technology. Potential and challenges. Advantages and disadvantages of hydrogen fuel.

**Hybrid Vehicles:** Types of hybrid systems, Objectives and Advantages of hybrid systems. Current status, Future developments and prospects of Hybrid Vehicles.

**Suggested Reading**

1. R. K. Rajput, "**Text book of Engineering Thermodynamics**". Laxmi Publications (p) Ltd, New Delhi, 2001.
2. Mahesh M rathore, "**Thermal Engineering**", Mc Graw Hill Education (India) Private Limited.
3. P. K. Nag, "**Engineering Thermodynamics**", tata Mc Graw Hill, 2005.
4. Y.V.C. Rao, "**An Introduction to Thermodynamics**", Universities Press, 2nd edition, 2010
5. Richard Stobart, "**Fuel Cell Technologies for Vehicles**"– SAE Hardbound papers.
6. Heinz Heisler, "**Advanced Vehicle Technologies**"– SAE International Publication.
7. Ronald K.Jurgen, "**Electric and Hybrid Electric Vehicles**" SAE International Publication.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 302 AE | **AUTOMOTIVE ENGINEERING DRAWING** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 2 | -- | 2 | -- | **30** | **70** | **3** |

**Course Objectives**

- To understand format of drawing sheet, angle of projections, isometric projections and practice on simple machine elements
- To practice free hand sketching of machine elements
- To understand assembly drawings of typical automotive parts such as Brake master cylinder, wheel cylinder, Fuel injector, Connecting rod, Eccentric, piston of petrol engine, Screw jack, etc.

**Course Outcomes**

- To prepare drawing sheet with title block, types of lines and dimensions, sketch orthographic projections including sectional views of simple machine elements
- Practice of free hand sketch of different screwed fasteners, joints and riveted joints Prepare and practice of generating assemble drawings from component drawings along with their sectional views for assemblies like - Brake master cylinder, Wheel cylinder, Connecting rod etc.,

**UNIT – I**

**Introduction to Machine Drawing**

Format of drawing sheet, title block, conventions of drawing lines and dimensions. First angle projections, convention for sectional views. Orthographic Projections including sectional views of simple machine elements from the given pictorial views.

**UNIT - II**

**Machine Elements**

Free hand sketching of the following machine elements

**Screwed Fastenings**

Screw thread nomenclature, thread series, designation, Types of thread profiles, multi start threads, Left and right hand thread, representation of threads, bolted joints, hexagonal nut, studded joint, eye bolt, Machine Screws and set screws, lock nut, castle nut and foundation bolts.

**Keys, Cotters and Pin Joints**

Introduction, saddle keys, feather keys, sunk keys, round keys, splined shaft, cotter joint with sleeve, cotter joint with socket and Spigot ends, cotter joint with a gib and knuckle joint.

**Shaft Couplings**

Split muff coupling, Flanged coupling, universal coupling, Oldham's coupling.

**Riveted Joints**

Introduction, classification of riveted joints, terminology of riveted joints, rivet heads, Lap joint, Butt joint, Zig zag joint, Single and double strap joint.

**UNIT - III**

**Assembly Drawings**

Assembly drawings from given details of component drawings and working description of the assembly. Ability to supply additional views. The exercises will be of assembly drawing not more than 7 to 8 typical parts, e.g., Brake master cylinder, Wheel cylinder, Universal coupling, Screw jack, Fuel injector, eccentric, Connecting rod, Lathe tail stock, Revolving centre, Swivel bearings, Single tool post, Piston of petrol engine and Plummer block.
These are only examples and actual exercise or examination may include any assembly.

**Suggested reading**

1. R.B.Gupta, "**Automobile Engineering Drawing"**, Satyaprakashan Tech India publications, 2010
2. N.D. Bhatt, "**Machine Drawing**", Charotar Publishing house, New Delhi, 28th edition, 1994.
3. N.Siddeshwar, "**Machine Drawing**", Tata McGraw Hill Publishing Co. Ltd., 5th edition, 1994
4. Basudeb Battacharayya, "**Machine Drawing**", oxford higher education, 1st edition, 2011.
5. K.L.Narayana, P.Kannaiah, K.Venkat Reddy, "**Machine Drawing"**, New Age International (P) Ltd., 2nd edition, 1999.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 303 AE | **FLUID MECHANICS & MACHINERY** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 4 | -- | -- | -- | **30** | **70** | **4** |

**Course Objectives**

- Know various fluid properties, concepts and methods of fluid measurement.
- Understand the basic concepts and principle of fluid flow.
- Study different equations of fluid motion and fluid dynamics.
- Analyze different flow characteristics of laminar flows.
- Understand the working principle of hydraulic turbines and pumps and their performance.

**Course Outcomes**

- Distinguish the properties of the fluids and different types of pressure and measure them.
- Explain different types of flows and analyze them.
- Analyze the flow between parallel plates and in pipes and also calculate drag and lift coefficients.
- Demonstrate the working principles of various turbines and estimate their performance.
- Demonstrate the working principles of various turbines and estimate their performance.

**UNIT -I**

**Basic Concepts and Properties of Fluid**

Definition, distinction between solid and fluid, , Properties of fluids, density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension, units and dimensions.

**Fluid statics**

Concept of fluid static pressure, absolute and gauge pressures, pressure measurements by manometers and pressure gauges.

**UNIT-II**

**Fluid Kinematics**

Flow visualization, lines of flow, types of flow, velocity field and acceleration, Continuity equation (one and three-dimensional differential forms), Equation of streamline, stream function, velocity potential function, circulation, flow net.

**Fluid Dynamics**

Equations of motion, Euler's equation along a streamline, Bernoulli's equation, applications. Venturi meter, Orifice meter, Pitot tube, dimensional analysis,

**UNIT-III**

**Incompressible Fluid Flow**

Viscous flow, Navier-Stoke's equation (Statement only), Shear stress-pressure gradient relationship, laminar flow between parallel plates, Laminar flow through circular tubes (Hagen poiseuille's), Hydraulic and energy gradient lines.

**Flow through pipes**

Darcy- Weisbach's equation, pipe roughness, friction factor, minor losses, flow through pipes in series and in parallel, power transmission, Boundary layer flows, boundary layer thickness, boundary layer separation, drag and lift coefficients.

**UNIT IV**

**Hydraulic Turbines**

Definition and classifications, Pelton turbine, Francis turbine, propeller turbine, Kaplan turbine, working principles, velocity triangles, work done, specific speed. Efficiencies, performance curve for turbines.

**UNIT V**

**Hydraulic Pumps**

Pumps: definition and classifications, Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves. Reciprocating pump: classification, working principles, indicator diagram, performance curves, cavitation in pumps, Rotary pumps: working principles of gear and vane pumps

**Suggested Reading**

1. Streeter, V.L., and Wylie, E.B., "**Fluid Mechanics**", McGraw-Hill, 1983.
2. P. N. Modi & S. M. Seth "**Hydraulic and Fluid Mechanics**" – standard book house, 2002.
3. Bansal, R.K., "**Fluid Mechanics and Hydraulics Machines**", ($5^{th}$ edition), Laxmi publications (P) Ltd. Delhi, 1995.
4. Kumar D. S., "**Fluid Mechanics and Fluid Power Engineering**", S. K. Kataria & Sons.
5. White, F.M., "**Fluid Mechanics**", Tata McGraw-Hill, $5^{th}$ Edition, New Delhi, 2003.
6. Som, S.K., and Biswas, G., "**Introduction to Fluid Mechanics and Fluid Machines**", Tata McGraw-Hill, $2^{nd}$ edition, 2004.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| ES 362 EE | **ELECTRICAL WIRING & MCROPROCESSOR LAB** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | -- | -- | -- | 2 | **25** | **50** | **1** |

**Course Objectives**

- To learn the testing and maintenance of batteries, starting motors and regulator.
- To know the diagnosis of Ignition System and automobile electrical wiring.
- To understand the Block Transfer, 8 bit addition & Subtraction Stepper Motor Interfacing

**Course Outcomes**

- Test and maintain batteries, starting motors, generators and regulator.
- Diagnosis of Ignition System and automobile electrical wiring.
- Explore the microprocessor basics and interfacing the stepper motor.

**List of Experiments:**

**I. Electrical laboratory**

1. Testing of Batteries and Battery maintenance
2. Testing of Starting Motors and Generators
3. Testing of Regulators and Cut – Outs
4. Diagnosis of Ignition System faults
5. Study of Automobile Electrical Wiring

**II. Microprocessor**

1. Block Transfer
2. 8 bit addition
3. Multiplication and Division
4. Maximum and minimum of block of data
5. Sorting
6. Stepper Motor Interfacing.

**Note:** Minimum ten experiments should be conducted in the semester

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 351 AE | **FLUID POWER LAB** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | -- | -- | -- | 2 | **25** | **50** | **1** |

**Course Objectives**

- To gain the knowledge about performance and characteristic curves of pumps and turbines.
- To understand the impact of jets on vanes
- To study hydraulic circuits and pneumatic circuit

**Course outcomes**

- Conduct the test on pumps and turbines and evaluate their performance.
- Demonstrate the principle of impact of jets on vanes.
- Explain hydraulic and pneumatic circuits.

**List of Experiments:**

1. Performance and characteristic curves of Self Priming pump
2. Performance and characteristic curves of Centrifugal/ Submergible pump
3. Performance and characteristic curves of Reciprocating pump
4. Performance and characteristic curves of Gear pump
5. Impact of Jets on Vanes
6. Performance and characteristic curves of Pelton Wheel
7. Performance and characteristic curves of Francis Turbine
8. Performance and characteristic curves of Kaplan Turbine
9. Drag and Lift coefficients of airfoil
10. Performance and characteristic curves of Turbo Wheel
11. Study of Hydraulic Circuits
12. Study of pneumatic Circuits

**Note:** Minimum ten experiments should be conducted in the semester

## SCHEME OF INSTRUCTION & EXAMINATION
B.E. IV - Semester
**(AUTOMOBILE ENGINEERING)**

| S.No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | Pr/ Drg | Contact Hrs / wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | BS 401 MT | Engineering Mathematics-IV | 3 | 1 | - | 4 | 30 | 70 | 3 | 3 |
| 2 | PC 401 AE | Automotive Petrol Engines | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | PC 402 AE | Automotive Chassis Components | 4 | - | - | 4 | 30 | 70 | 3 | 4 |
| 4 | PC 403AE | Metallurgy & Material Testing | 4 | - | - | 4 | 30 | 70 | 3 | 4 |
| 5 | PC 402 ME | Kinematics of Machines | 4 | 1 | - | 5 | 30 | 70 | 3 | 4 |
| 6 | MC 916 CE | Environmental Sciences | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical / Laboratory Courses** | | | | | | | | | | |
| 7 | PC 451 AE | Metallurgy & Material Testing Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 8 | PC 452 AE | Automotive Chassis Components Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 9 | PC 453 AE | Computational Methods Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| **Total** | | | **21** | **2** | **6** | **29** | **255** | **570** | | **24** |

BS: Basic Sciences ES: Engineering Sciences MC: Mandatory Course
PC: Professional Course HS: Humanities and Sciences
L: Lectures T: Tutorials Pr : Practicals Drg: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| BS401 MT | **ENGINEERING MATHEMATICS- IV** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | 1 | -- | -- | **30** | **70** | **3** |

**Course Objectives**

- To introduce transforms Fourier , Z-transforms and their properties
- To introduce a few numerical methods to solve certain types of problems
- To understand curve fitting, correlation and regression
- To provide the knowledge of probability distributions like uniform, normal and exponential distributions, tests of significance, correlation and regression.

**Course Outcome**

- Evaluate certain types of improper integrals.
- Solve difference equations using z-transforms
- Find numerical solution of algebraic, trancendental equations and ordirnary differential equations.
- Perform a regression analysis and to compute and interpret the coefficient of correlation

**UNIT- I**

**Fourier transforms**: Introduction, Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral, Fourier transform, Fourier sine and cosine transforms, Finite Fourier sine and cosine transforms, Properties of Fourier transforms, Convolution theorem for Fourier transforms.

**UNIT- II**

**Z-Transforms:** Introduction, basic theory of Z-transforms, Z-transforms of standard sequences, existence of Z-transform, linearity property, translation theorem, scaling property, initial and final value theorems, differentiation of Z-transform, convolution theorem, solution of difference equations using Z-transforms.

**UNIT- III**

**Numerical methods:** Solution of Algebraic and Transcendental equations: Bisection method, Newton-Raphson method, Solution of linear system of equations: Gauss elimination method, Gauss- Seidel iteration method, Interpolation: Lagrange's interpolation, Newton's divided difference interpolation, Newton's Forward and Backward difference interpolations, Numerical differentiation, Numerical solutions of ordinary differential equations : Taylor's series method, Euler method, Runge-Kutta method of $4^{th}$ order.

**UNIT- IV**

**Curve fitting**: Curve fitting by method of least squares, correlation and regression, types of correlations, Karl Pearson's coefficient of correlation, Spearman's rank correlation coefficient, equal ranks, equations to the lines of regression.

**UNIT- V**

**Probability:**

Random variables, Uniform, Normal, Exponential distributions, Mean, median, mode and standard deviation, Conditional probability and Baye's theorem, Tests of significance, t-test, F-test and $\chi^2$ test.

**Suggested Reading:**

1. R.K.Jain & S.R.K.Iyengar, *Advanced Engineering Mathematics*, Narosa Publications, 4th Edition, 2014.
2. B.S.Grewal, *Higher Engineering Mathematics*, Khanna Publications, 43rd Edition, 2014.
3. Vasishtha and Gupta, *Integral Transforms*, Krishnan Prakashan Publications, 2014.
4. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons ,9th Edition, 2012.
5. S.C.Gupta and V.K.Kapoor, *Fundamentals of Mathematical Statistics,* Sultan Chand& Sons, 2014.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 401AE | **AUTOMOTIVE PETROL ENGINES** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | -- | -- | -- | **30** | **70** | **3** |

**Course Objectives:**

- To understand the construction, working principles of 2 stroke and 4 stroke petrol engines.
- To learn about working of carburetor at different operating conditions and fuel supply system.
- To understand the requirement and operation and different types of ignition systems.
- To know the phenomenon of combustion and types of combustion chambers.
- To understand the requirement and operation and different types of cooling and lubrication systems.

**Course Outcomes:**

- To demonstrate constructional details and working principles of petrol engines and also to explain port timing and valve timing diagrams.
- Apply the knowledge to select a carburettor and fuel supply system suitable for different operating conditions of the engine.
- To distinguish between different types of ignition systems and explain the construction of a spark plug.
- To demonstrate the stages of combustion, analyze the effect of various factors on combustion and distinguish between different types of combustion chambers.
- To explain various types of cooling and lubricating systems and select a suitable systems for the proper functioning of the engine.

**UNIT -I**

**Engine Construction and Operation**

Constructional details of four stroke petrol engine, working principle, air standard Otto cycle, actual indicator diagram, two stroke engine construction and operation, comparison of four stroke and two stroke engine operation, firing order and its significance. Port Timing, Valve Timing of petrol engines.

**UNIT -II**

**SI Engine Fuel System**

Carburettor working principle, requirements of an automotive carburettor, starting, idling, acceleration and normal circuits of carburettors. Compensation, maximum power devices, constant choke and constant vacuum carburettors, fuel feed systems; mechanical and electrical fuel feed pumps. Petrol injection, MPFI.

**UNIT -III**

**Ignition System**

Types and working of battery coil and magneto ignition systems, relative merits and demerits, centrifugal and vacuum advance mechanisms. Types and construction of spark plugs, electronic ignition systems.

**UNIT -IV**

**Combustion and Combustion Chambers**

Combustion in SI engine: stages of combustion, flame propagation, rate of pressure rise, abnormal combustion, detonation, effect of engine variables on knock, knock rating. Combustion chambers: different types, factors controlling combustion chamber design.

**UNIT -V**

**Cooling and Lubrication Systems**

Need for cooling system, Types of cooling system: air cooling system, liquid cooling system, forced circulation system, pressure cooling system. Lubrication system; mist, wet sump lubrication system. Properties of lubricants.

**Suggested Reading**

1. Ganesan.V., **"Internal Combustion Engines",** Tata McGraw-Hill Publishing Co., New Delhi, 2003.
2. M.L.Mathur and R.P.Sharma, **"A course in Internal Combustion Engines",** Dhanpat Rai & Sons Publications, New Delhi, 2001.
3. K.K.Ramalingam, **"Internal Combustion Engines",** Scitech Publications, Chennai, 2000.
4. Heldt P.M., **"High Speed Combustion Engines",** Oxford IBH Publishing Co., Calcutta, 1975.
5. Pulkrabek **"Engineering Fundamentals of the Internal Combustion Engines",** Practice Hall of India, 2003.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 402AE | **AUTOMOTIVE CHASSIS COMPONENTS** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 4 | -- | -- | -- | **30** | **70** | **4** |

**Course Objectives**

- To understand the basic concepts of structure and frame of an automobile and discuss the various types of frames used in automobiles along with their constructional details.
- To understand constructional details and working of front axles, steering geometry.
- To understand different types of drives used in automobiles, namely the Hotchkiss drive, Torque tube drive and the final drives, components of transmission and rear axle.
- To understand the components and working of different types of suspension system.
- To understand the components and working of different types of brakes.

**Course Outcomes**

- To identify different types of frames and assess how loads act on different cross-sections of frames
- To demonstrate working of front axles, steering geometry and select the materials required for them.
- To explain different types of drives used in automobiles, namely the Hotchkiss drive, Torque tube drive and the final drives, components of transmission and rear axle.
- To explain different types of suspension systems and assess the suitability of a suspension system based on the type of vehicle
- To explain different types of Braking system and distinguish between them.

**UNIT –I**

**Introduction**

Types of chassis layout with reference to power plant locations and drives; vehicle frames, various types of frames, constructional details, materials ,testing of vehicle frames, unitized frame body construction.

**UNIT –II**

**Front Axle and Steering System**

Types of front axles, construction details, materials, front wheel geometry: caster, camber, king pin inclination, toe-in; Conditions for true rolling motion of wheels during steering; steering geometry, Davis steering system and Ackerman, constructional details of steering linkages, different types of steering gear boxes, steering linkages and layouts, turning radius, wheel wobble, power assisted steering, steering of crawler tractors.

**UNIT -III**

**Drive Line**

Effect of driving thrust and torque reactions, Hotchkiss drive, torque tube drive and radius rods, propeller shaft, universal joints, front wheel drive, different types of final drive, double reduction and twin speed final drives, differential principle, construction details of differential unit. Non-slip differential, differential locks, differential housings, construction

of rear axles, types of loads acting on rear axles, fully floating, three quarter floating and semi floating rear axles, rear axle housing, construction of different types of axle housings, multi axle vehicles.

**UNIT –IV**

**Suspension System**

Need of suspension system, types of suspension, suspension springs, construction details and characteristics of leaf spring, coil spring and torsion bar springs; Independent suspension, rubber suspension, pneumatic suspension and shock absorbers.

**UNIT –V**

**Braking System**

Classification of brakes, drum brakes and disc brakes, constructional details, theory of braking, concept of dual brake system, parking brake, hydraulic system, vacuum assisted system, air brake system, antilock braking system, retarded engine brakes, eddy retarders.

**Suggested Reading**

1. Kirpal Singh, **"Automobile Engineering- vol-1"** Standard publishers, 2007.
2. R.B Gupta, **"Automobile Engineering- vol-1"** Tech India, 2007.
3. K.K. Ramalingam, **"Automobile Engineering"** Scitech publication, 2001.
4. Joseph Heitner, **"Automobile Mechanics"** CBS Publishers, 2nd edition.
5. Crouse/ Anglin, **"Automotive Mechanics"** Tata Mc Graw Hill, 9th edition.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 403AE | **METALLURGY & MATERIAL TESTING** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 4 | -- | -- | -- | **30** | **70** | **4** |

**Course Objectives**

- To understand imperfections and dislocations in crystals, Types of fractures in metals, hot and cold working processes.
- To understand fatigue, creep and diffusion.
- To understand the structure of alloys, structure and characteristics of plain carbon steels and cast irons.
- To understand different methods of heat treatment.
- To understand materials used for automobiles

**Course Outcomes**

- Identify the defects in metals and differentiate hot working and cold working, recovery, recrystallization and grain growth.
- To analyze fatigue crack propagation, effect of metallurgical variables, creep deformation mechanism apply diffusion theory.
- Construct and interpret the phase equilibrium diagrams and Iron-Iron carbide equilibrium diagram
- Explain the behavior of materials upon heat treatment, construct and interpret TTT diagram and appreciate the importance of case hardening
- Describe various metallic and non-metallic materials and select them for automobiles

.

**UNIT-I**

Imperfections in crystals, Dislocations in crystals, Types of dislocations, Critical resolved shear stress, Effect of slip and twinning on the plastic deformation, Jogs and its effect on yield phenomenon, Hall-Petch equation, Ornge Pell effect, cold and hot working, strain hardening and Bauchinger effect, recovery, Recrystallization, Grain growth and its effect on mechanical properties of metals.

**Fracture**

Types of fracture in metals, modes of fracture, Griffith theory of brittle fracture, Crack propagation, ductile fracture, Fracture under combined stress.

**UNIT-II**

**Fatigue**

S-N curve, Structure of fatigue fracture specimen. Fatigue crack propagation, effect of metallurgical variables on fatigue of metal, low cycle fatigue, cumulative fatigue and fatigue damage, Experimental determination of fatigue strength (RR-Moore Test), Factors to be considered for the improvement of the fatigue life.

**Creep**

Creep strength, creep curve, creep deformation mechanisms, creep test, differences between creep curve and stress rupture curve.

**Diffusion**

Fick's law of diffusion, application of diffusion theory in mechanical engineering.

**UNIT-III**

**Structure of Alloys**

Construction and interpretation of thermal equilibrium diagram of binary nonferrous alloys, study of eutectic, eutectoid, peritectic, peritectoid reactions. Iron-Iron carbide Equilibrium diagram, construction and interpretation.

Types of plain carbon steels, cast iron and their properties and characteristics.

**UNIT-IV**

**Heat Treatment**

Annealing, Normalising, Hardening, Tempering, Construction and interpretation of T.T.T Curve. Austempering and Martempering.

**Case Hardening**

Carburising, Nitriding, Carbo-nitriding, Flame Hardening and Induction Hardening. Brief introduction of Age hardening.

**UNIT-V**

**Selection of materials**

Criteria of selecting materials for automotive components viz Cylinder block, Cylinder head, Piston, Piston ring, Gudgeon pin, Connecting rod, Crank shaft, Crank case, Cam, Cam shaft, Engine valve, Gear wheel, Clutch plate, Axle bearings, Chassis, Spring, body panel radiator, brake lining etc. Application of non-metallic materials such as composite, ceramic and polymers in automobile.

**Testing of materials**

Universal testing machine-tension, compression, bending and shear tests, Hardness testing-Rockwell, Brinnell's and Vicker's diamond methods. Toughness measurement- Izod and Charpy methods, Torsion test.

**Non-Destructive Testing methods**

Ultrasonic testing, Magnetic Particle Testing, Liquid penetrant testing, Radiographic testing, Eddy Current Testing, Visual Testing and Thermal/Infra Red Testing.

**Suggested Reading**

1. V. Raghavan, **"Material Science and Engineering",** Printice Hall of India Ltd., 4th edition. 1994
2. S.H. Avner, **"Introduction to physical metallurgy",** Tata Mc Graw Hill, 2nd edition. 1997
3. S.P Nayak, **"Engineering Metallurgy and Material Science",** Charoter publishing House, 6th edition. 1995
4. E. Dieter, **"Mechanical Metallurgy",** Metric Edition. Tata Mc Graw Hill, 3nd edition. 1997
5. Serope kalpakjain and Steven R- Schmid, **"Manufacturing Engineering & Technology",** Pearson, 4th edition. 2006.
6. Khanna.O.P., **"Material Science and Metallurgy"** Dhanpat Rai & Sons, 1992.
7. Kapoor, **"Material Science and Processes",** New India Publishing House, 1987.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 402ME | **KINEMATICS OF MACHINES** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 4 | 1 | -- | -- | **30** | **70** | **4** |

**Course Objectives**

- To understand the basic elements of machinery and their motion characteristics
- To know the kinematic properties of mechanisms and machines
- To understand basic machine elements
- To know classification and applications of cams, gears and gear-trains

**Course Outcomes**

- Determine the degree of freedom of a given mechanical system.
- Understand the importance of mechanisms and their applications.
- Develop new mechanisms for various applications.
- Develop a power drive system for a specific system.
- Understand the importance of friction and its applications.

**UNIT-I**

**Basics of Mechanisms**

Definition of link, element, pair, kinematic chain, mechanism and machine, Grubler's criterion, single and double slider chains, inversions of quadratic cycle chain, inversions of single and double slider crank chains. Fundamentals of coupler curves, Robert's law, mechanism with lower pairs and straight line motion mechanism, Pantograph, Peaucellier, Hart, Davis and Ackerman's Steering gear mechanisms

**UNIT-II**

**Analysis of mechanisms**

Graphical methods to find velocities of mechanisms, instantaneous centre, body centre and space centre, Kennedy's theorem, Graphical determination of acceleration of different mechanisms including Coriolis component of acceleration. Analytical method to find the velocity and acceleration, analysis of four bar mechanism with turning parts, Freudenstein's method for four bar linkage synthesis.

**UNIT-III**

**Laws of Friction**

Friction in screw threads, pivots, collars and clutches, friction axis of link and friction circle

**Belts and Ropes**

Open and closed belt drives, length of belt, ratio of tensions, effect of centrifugal tension and initial tension over power transmission, condition for maximum power

**Brakes and Dynamometers**

Block or shoe, band and block, internal expanding shoe brake, Prony, Rope brake, belt transmission, Torsion dynamometers.

**UNIT-IV**

**Cams**

Types of cams and followers, Displacement diagrams for followers, uniform motion, parabolic motion, simple harmonic motion, cycloidal motion- drawing cam profile with knife-edge follower, translating roller follower and translating Flat follower, cams of specified contour: Eccentric circle cam with translating flat power, Eccentric circle cam with translating roller follower.

**UNIT-V**

**Gears**

Classification of gears. Spur gears- Nomenclature, law of gear tooth action, involute as gear tooth profile, interference of involute gears, minimum number of teeth to avoid interference, contact ratio, cycloidal tooth profile, comparison of involute and cycloidal tooth profile.

Helical gears: Helical gear tooth relations, contact of helical gear teeth. Gear trains- Simple and compound, reverted, and epicyclic gear trains.

**Suggested Reading**

1. S.S. Rattan, **"Theory of Machines"**, Tata McGraw-Hill, 3rd Edition, 2009.
2. J.E.Shigley, **"Theories of Machines"**, McGraw-Hill Publications, 2005.
3. Thomas Bevan, **"Theory of Machines",** CBS Publishers,
4. J.S. Rao and R.V. Dukkipati, **"Mechanisms and Machine Theory",** Wiley Eastern Limited, 1992.
5. Amitabha Ghosh and Ashok Kumar Mallik, **"Theory of Mechanisms and Machines",** East West Press Pvt. Ltd, 2008

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| MC 916 CE | **ENVIRONMENTAL SCIENCES** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | -- | -- | -- | **30** | **70** | **3** |

**Course Objectives**

- To study the basic concepts, sources of water, floods and their impact on environment
- To know the ecosystems and energy resource systems
- To understand the Biodiversity concepts and their advantages
- To study the different pollutions and their impact on environment
- To know the social and environment related issues and their preventive measures

**Course Outcomes**

- Awareness of effects of hazardous environment.
- Idea about optimum utilization of natural resources.
- Be a catalyst in moving towards Green technologies
- Information about rules and regulations of pollution control

**UNIT-I**

**Environmental studies**

Definition, scope and importance, need for public awareness. Natural resources: Water resources; use and over utilization of surface and ground water, Floods, drought, conflicts over water, dams-benefits and problems. Effects of modern Agriculture, Fertilizer-pesticide problems, water logging and salinity.

**UNIT-II**

**Ecosystems**

Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in ecosystem, food chains, ecological pyramids, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) Energy resources: Growing energy needs renewable and non-renewable energy sources. Land Resources, land as a resource, land degradation, soil erosion and desertification.

**UNIT-III**

**Biodiversity**

Genetic species and ecosystem diversity, bio-geographical classification of India. Value of biodiversity, threats to biodiversity, endangered and endemic species of India, conservation of biodiversity.

**UNIT-IV**

**Environmental Pollution**

Cause, effects and control measures of air pollution, water pollution, soil pollution, noise pollution , thermal pollution and solid waste management. Environmental protection act: Air, water, forest and wild life Acts, enforcement of Environmental legislation.

**UNIT-V**

**Social issues and the Environment**

Water conservation, watershed management, and environmental ethics. Climate change, global warming, acid rain, ozone layer depletion. Disaster management: Types of disasters, impact of disasters on environment, infrastructure, and development. Basic principles of disaster mitigation, disaster management, and methodology, disaster management cycle, and disaster management in India.

**Suggested Reading**

1. De A.K., **"Environmental Chemistry",** Wiley Eastern Ltd.,
2. Odum E.P., **"Fundamentals of Ecology",** W.B. Sunders Co., USA.
3. Rao M.N and Datta A.K., **"Waste Water Treatment",** Oxford and IBK Publications.
4. Benny Joseph, **"Environmental studies",** Tata McGraw Hill, 2005
5. Sharma V.K., **"Disaster *Management",*** National Centre for Disaster management, IIPE, Delhi,1999

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 451 AE | **METALLURGY & MATERIAL TESTING LAB** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | -- | -- | -- | 2 | **25** | **50** | **1** |

**Course Objectives**

- To know and understand the experiments on various materials to assess their behavior / limitations.
- To understand the Shear force, bending moment and deflections of different types of beams.
- To know the structure of Ferrous and Non-Ferrous materials, properties and their practical applications.
- To understand the heat treatment process of steel

**Course outcomes**

- Conduct test on various materials and find out their properties.
- Conduct test on different types of beams and evaluate Shear force, bending moment and deflections.
- Identify structure of Ferrous and Non-Ferrous materials, properties.
- Conduct heat treatment test on steel and study their properties.

**List of Experiments:**

1. Direct tension test on plain carbon steels
2. Young's modulus of metal specimen by direct tension test
3. Brinnell's and Rockwell's hardness test
4. Compression test
5. Torsion test to determine the rigidity modulus of a shaft
6. Fatigue test
7. Procedure of metallurgical specimen preparation
8. Study of metallurgical microscope
9. Study of Iron-Iron Carbon diagram
10. Metallographic study and analysis of plain carbon steels, cast iron, non-ferrous alloys like: brass, bronze, Al—Si alloys.
11. Demonstration of heat treatment process
12. Study of microstructure after hardening, normalizing and annealing of steel specimen.

Note: minimum ten experiments should be conducted in the semester

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 452 AE | **AUTOMOTIVE CHASSIS COMPONENTS LAB** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | -- | -- | -- | 2 | **25** | **50** | **1** |

**Course Objectives**

- Know the constructional details of automobile frame, front & rear axles
- Work on different types of clutches, differential, gear boxes, brakes, suspension systems used in automobiles along with their components
- Assembling and disassembling of clutches, front axle, rear axle, steering, braking, suspension systems and differential gear box.

**Course outcomes**

- Demonstrate constructional details of automobile frame, front & rear axles.
- Explain different types of clutches, differential, gear boxes, brakes, suspension systems used in automobiles along with their components.
- Assemble and dismantle clutches, front axle, rear axle, steering, braking, suspension systems and differential gear box.

**List of Experiments**:

**Study and measurement of following chassis frames:**

1. Light Motor Vehicle frame
2. Heavy Duty Vehicle frame

**Study, Disassembling and Assembling:**

3. Front Axle
4. Rear Axle
5. Differential
6. Steering Systems along with any two types of steering gear box
7. Braking Systems: Hydraulic, Servo Vacuum, compressed air power brakes
8. Leaf Spring, coil spring, torsion bar spring, hydraulic shock absorber
9. Assembly of different types of clutches
10. Gear Box
11. Transfer Case

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| PC 453 AE | **COMPUTATIONAL METHODS LAB** | | | | | | Core |
| Prerequisite | Contact hours per week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | -- | -- | -- | 2 | **25** | **50** | **1** |

**Course Objectives**

- Learn the MATLAB environment and its programming fundamentals
- Understand programs using commands and functions
- Understand to handle polynomials, and use 2D Graphic commands

**Course outcomes**

- Explain MATLAB environment and its programming fundamentals
- Write programs using commands and functions
- Handle polynomials, and use 2D Graphic commands

**List of Experiments**

1. Practicing MATLAB environment with simple exercises to familiarize Command Window, History, Workspace, Current Directory, Figure window, Edit window, Shortcuts, Help files.
2. Data types, Constants and Variables, Character constants, operators, Assignment statements.
3. Additional data types.
4. Control Structures: For loops, While, If control structures, Switch, Break, Continue statements.
5. Input-Output functions, Reading and Storing Data.
6. Vectors and Matrices, commands to operate on vectors and matrices.
7. Program to display a Matrix
8. Program to Addition of matrix
9. Program to transpose of a Matrix.
10. Arithmetic operations on Matrices, Relational operations on Matrices, Logical operations on Matrices.
11. Polynomial Evaluation, Roots of Polynomial, Arithmetic operations on Polynomials.
12. Graphics: 2D plots, Printing Labels, Grid & Axes box, Text in plot, Bar and Pie chart.
13. Advanced Graphics: 3D Plots and parametric plots

**Suggested Reading**

1. Bansal R.K, Goel A.K, Sharma M.K, "MATLAB and its Applications in Engineering", Pearson Education, 2012.
2. Amos Gilat, "MATLAB-An Introduction with Applications", Wiley India, 2009.
3. Stephen.J.Chapman, "Programming in MATLAB for Engineers", Cengage Learning, 2011.