Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Automobile Engineering

(Applicable from the academic session 2018-2019)

Second Year Fourth Semester

Subject Code : ES-AUE401	**Category:** Engineering Science Courses
Subject Name : Materials Engineering	**Semester** : Fourth
L-T-P : **3-0-0**	**Credit:3**
Pre-Requisites: No prerequisite	

Objectives:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams.
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course Contents:

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. (6)

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. (6)

Mechanisms of Plastic and Elastic deformations, Slip and Twinning, Recover Recrystallization and Grain growth- Strengthening Mechanism- Strain hardening, Precipitation hardening, Refinement of Grain, solid solution strengthening, Types of Fracture-, Ductile and Brittle fracture- Griffith's theory, Creep - Mechanisms of Creep- Creep resistant materials, Fatigue Failure- SN curve- Factors affecting fatigue life, prevention of fatigue failure. (9)

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron. (6)

Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening. (6)

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons.
Advance materials for automotive components: Characteristics, advantage/ disadvantages, and applications. Ceramic Materials: What is ceramics; common ceramic materials and their characteristics; How ceramics are made—sintering and vitrification process; Ceramic structures; Properties and applications. Composite materials: What is composites; Polymers matrix and their applications; Metal matrix and ceramic matrix composites and their applications; How composites are made. (5)

Criteria for selecting materials for automotive components viz. Cylinder Block, Cylinder Head, Piston, Piston Ring, Gudgeon pin, Connecting Rod, Crank Shaft, Cam Shaft, Cam, Engine Valve, Gear, Crown wheel and pinion, Clutch plate, Axle shaft, Chassis, spring, body panel, Brake lining etc. (2)

Course Outcomes:

1. Student will be able to identify crystal structures for various materials and understand the defects in such structures.
2. Understand how to tailor material properties of ferrous and non-ferrous alloys.
3. How to quantify mechanical integrity and failure in materials.

Text Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

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Subject Code : PC-AUE401	**Category:** Professional Core courses
Subject Name : Strength of Materials	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Objectives:

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads.
2. To calculate the elastic deformation occurring in various simple geometries for different types of loading.

Course Contents:

Deformation in solids - Hooke's law, stress and strain- tension, compression and shear stresses – elastic constants and their relations- volumetric, linear and shear strains - principal stresses and principal planes - Mohr's circle. (10)

Beams and types of transverse loading on beams- shear force and bend moment diagrams - Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. (8)

Deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.
Buckling of columns, Euler's theory, critical loads for different types of constraints. (10)

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs. (8)

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure. (8)

Course Outcomes:

1. After completing this course, the students should be able to recognise various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components.
2. The students will be able to evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading.

Text Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.
4. Debabrata Nag and Abhijit Chanda, Fundamentals of Strength of Materials, Wiley India.

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Subject Code : PC-AUE402	**Category:** Professional Core courses
Subject Name : Fluid Mechanics & Hydraulic Machines	**Semester** : Fourth
L-T-P : **4-0-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Objectives:

1. To learn about the application of mass and momentum conservation laws for fluid flows.
2. To understand the importance of dimensional analysis.
3. To obtain the velocity and pressure variations in various types of simple flows.
4. To analyze the flow in water pumps and turbines.

Course Contents:

Definition of fluid, Newton's law of viscosity, Units and dimensions - Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications. (9)

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram. (9)

Need for dimensional analysis–methods of dimension analysis–Similitude–types of similitude. Dimensionless parameters–application of dimensionless parameters–Model analysis. (6)

Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps - Reciprocating pump – working principle. (8)

Impact of Jet, Classification of water turbines, heads and efficiencies, velocity triangles - Axial, radial and mixed flow turbines - Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube - Specific speed, unit quantities, performance curves for turbines – governing of turbines. (8)

Course Outcomes:

1. Upon completion of this course, students will be able to mathematically analyze simple flow situations.
2. They will be able to evaluate the performance of pumps and turbines.

Text Books:

1. Fluid Mechanics and Machinery, R.K.Bansal, Laxmi Publication.
2. Introduction to Fluid Mechanics & Fluid Machines, Som and Biswas, TMH.
3. A Textbook on Fluid Mechanics and Machines, S.Pati, McGrawHill.
4. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010.
5. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House.

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Subject Code : PC-AUE403	**Category:** Professional Core courses
Subject Name : Theory of Machine	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components.
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.
3. To be able to design some linkage mechanisms and cam systems to generate specified output motion.
4. To understand the kinematics of gear trains.

Contents:

Classification of mechanisms-Basic kinematic concepts and definitions-Degree of freedom, mobility - Grashof's law, Gruebler's criterion for plane mechanism, Kinematic inversions of four bar chain and slider crank chains-Limit positions - Mechanical advantage-Transmission angle-Description of some common mechanisms-Quick return mechanism, straight line generators (pantograph) -Universal Joint-Rocker mechanisms. (8)

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations kinematic analysis of simple mechanisms - slider crank mechanism dynamics-Coincident points - Coriolis component of acceleration-introduction to linkage synthesis- three position graphical synthesis for motion and path generation. (8)

Classification of cams and followers-Terminology and definitions-Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions specified contour cams-circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller, flat face and knife edge followers. (8)

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/ undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics. (8)

Belt-drive – introduction; Law of belting, Length of flat belt for open and cross belt connections; Stepped pulley for open flat belt; Tension in flat belt and V-belts; Power transmitted in belt drive. (8)

Course Outcomes:

1. After completing this course, the students can design various types of linkage mechanisms for obtaining specific motion and analyse them for optimal functioning.

Text Books:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.

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Subject Code : PC-AUE404	**Category:** Professional Core courses
Subject Name : Metrology & Instrumentation	**Semester** : Fourth
L-T-P : **3-0-0**	**Credit:3**
Pre-Requisites: No-prerequisite	

Objectives:

1. To understand the working of linear and angular measuring instruments.
2. To familiarize with the working of optical measuring instruments and fundamentals of limits and limit gauges.
3. To give basic idea about various methods for measurement of screw thread and surface finish parameters.
4. To give an exposure to advanced measuring devices and machine tool metrology.
5. To provide students an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
6. To provide basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Course Contents:

Module 1: Concept of measurement:-Introduction to Metrology; Need for high precision measurements; Terminologies in Measurement- Precision, accuracy, sensitivity, calibration, resolution. Errors in Measurement, types of errors, Abbe's Principle. Basic standards of length- Line standard, End standards, Wavelength standard; Various Shop floor standards. Linear Measurement – Slip gauges, wringing, grades; Surface plate; Dial indicators; Height gauges and Vernier calliper; screw gauge. Comparators- mechanical, electrical, optical and pneumatic. Angular Measurement – Bevel protractor; Sine Bar, principle and use of sine bar, sine centre; Angle gauges. Sprit level; Angle Dekkor; Clinometers.

(8)

Module 2: Limits and Limit gauges – Making to suit, selective assembly, systems of limits and fits; Types of fits; Hole basis system and Shaft basis system. Tolerance, allowance and deviation (as per BIS). Limit Gauges – GO and NO GO gauges; types of limit gauges. Gauge design - Taylor's principle of gauging; Gauge tolerance, disposition of gauge tolerance, wear allowance. Optical Measuring Instruments: - Benefits of light waves as standards; Monochromatic light; Principle of Interference. Interference band, optical flat, surface measurement. Interferometers – NPL, Pitter-NPL, auto collimator. (8)

Module 3: Screw thread measurement – Screw thread terminology; Measurement of major diameter; root diameter; pitch; effective diameter with two wire method and three wire method. Measurement of flank angle and form by profile projector and microscope. Measurement of surface texture – roughness and waviness; Analysis of surface traces, peak to valley height, R.M.S. value, Centre Line Average and Ra value, Rt, Rz etc. Methods of measuring surface roughness – Stylus probe, Tomlinson surface meter, Talysurf; surface roughness measurement – assessment length, roughness width cut-off, sampling length and evaluation length.

(8)

Module 4: Introduction to Digital Measurement – significance of Digital measurement; methods; Classification. Stages in generalized measuring system – Sensor-Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers. Performance characteristic of measuring devices. Drift, Resolution, Threshold, Hysteresis, Static calibration. Dynamic characteristics-different order systems and their response-, Measuring lag, Fidelity, Dynamic error; Transducers – Working, Classification of transducers. Motion and Dimension measurement – LVDT – Principle, applications, advantages and limitations. (8)

Module 5: Strain and Stress Measurement - Electrical resistance strain gauge - Principle, operation. Measurement of Force and Torque – Strain-Gauge Load Cells, Hydraulic and Pneumatic load cells – force

measurement using piezoelectric quartz crystal. Torque Measurement – Dynamometers – Mechanical, Hydraulic and Electrical. Vibration measurement – Vibrometers and Accelerometers. Temperature Measurement – Use of Thermal Expansion – Liquid-in-glass thermometers, Bimetallic strip thermometer, Pressure thermometers. Thermocouples – Resistance Temperature Detectors (RTD); Thermistors; Pyrometers. (8)

Course Outcomes:

Upon successful completion of the course, student will have

1. Understand the working of linear and angular measuring instruments.
2. Know the fundamentals of limits and limit gauges, various methods for measurement of screw thread and surface roughness parameters and the working of optical measuring instruments.
3. Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
4. Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Text Books:

1. Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw-Hill, 2009
2. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004
3. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS,1990
4. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E, Pearson Prentice Hall, 2007

R.K. Rajput, Mechanical Measurements & Instrumentation, S.K.Kataria & Sons.

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Subject Code : PC-AUE491	**Category:** Professional Core courses
Subject Name : Manufacturing and Testing Lab	**Semester** : fourth
L-T-P : **0-0-3**	**Credit:1.5**
Pre-Requisites: No prerequisite	

List of Experiments:

About 12 experiments will be carried out as listed below.

1. Impact tests: Charpy or Izod tests; Hardness test, Test for drawability of sheet metals through cupping test;
2. Fatigue test of a typical sample.
3. Sample preparation and etching of ferrous and non-ferrous metals and alloys for metallographic observation;
4. Experiments on heat treatment of carbon steels under different rates of cooling including quenching, and testing for the change in hardness, and observing its microstructural changes for standard specimen through metallographic studies.
5. Determining spring stiffness under tension and compressive loads; Strain gauge based strain/ deflection/ force measurement of a cantilever beam;
6. Tension Test and Compression Test of ductile and brittle materials: stress-strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation and percentage reduction in areas, observation of fractured surfaces; Bend and rebend test of flat test pieces, determination of bending stresses;
7. Torsion Test; Experiments on friction: determination of coefficient of friction;
8. Sand preparation and testing: specimen preparation for testing permeability, clay content, grain fineness number, moisture content, green compression strength, green shear strength, splitting strength, hardness, etc.;
9. Casting of metals after preparation of a suitable type moulds; Experiments on properties of post casting, fettling, cleaning, deburring, and polishing operations;
10. Same experiment for another type of moulds.
11. Practicing smithy or forging of carbon steels and testing for its property changes;
12. Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW
13. Testing for Joint defects in GMAW with visual inspection and DP test.
14. Surface roughness measurement.
15. Measurement of threads, gears.

Course Outcomes:

Students will be able to

1. List the characteristics of material.
2. Interpret different engineering material properties.
3. Identify different destructive and nondestructive testing.
4. Translate suitable testing for proper application.
5. Compute stress, strains and deformation of engineering materials.

6. Demonstrate to find out hardness of engineering materials.
7. Attain basic knowledge on pattern making.
8. Construct moulds.
9. Examine properties of mould material in casting.
10. Determine and explain the various measurement systems, surface metrology, gears measurement.

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Subject Code : MC-401	**Category:** Mandatory courses
Subject Name : Environmental Science	**Semester** : Third
L-T-P : **2-0-0**	**Credit: 0**
Pre-Requisites: No-prerequisite	

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethoses. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two types of activities.

(a) Awareness Activities:

I. Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
II. Slogan making event
III. Poster making event
IV. Cycle rally
V. Lectures from experts

(b) Actual Activities:

I. Plantation
II. Gifting a tree to see its full growth
III. Cleanliness drive
IV. Drive for segregation of waste
V. To live some big environmentalist for a week or so to understand his work
VI. To work in kitchen garden for mess
VII. To know about the different varieties of plants
VIII. Shutting down the fans and ACs of the campus for an hour or so