

# **UNIVERSITY OF MUMBAI**



## **Bachelor of Engineering**

**Automobile Engineering (Second Year – Sem. III & IV)**

**Revised course (REV- 2012) from Academic Year 2012 -13,**

**Under**

## **FACULTY OF TECHNOLOGY**

(As per Semester Based Credit and Grading System)

**Program Structure for B E Automobile Engineering**  
**S. E. (Mechanical/Automobile) Sem.- IV**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract.	Theory	Pract.	Total			
AEC401	Applied Mathematics IV <sup>@</sup>	4	--	4	--	4			
AEC402	Fluid Mechanics <sup>§</sup>	4	2	4	1	5			
AEC403	Theory of Machines- I <sup>§</sup>	4	2	4	1	5			
AEC404	Production Process- II <sup>§</sup>	4	--	4	--	4			
AEC405	Material Technology <sup>§</sup>	3	2	3	1	4			
AEC406	Industrial Electronics <sup>§</sup>	3	2	3	1	4			
AEL407	Machine Shop Practice- II <sup>§</sup>	--	4	--	2	2			
<b>Total</b>		<b>22</b>	<b>12</b>	<b>22</b>	<b>6</b>	<b>28</b>			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
AEC401	Applied Mathematics IV <sup>@</sup>	20	20	20	80	03	--	--	100
AEC402	Fluid Mechanics <sup>§</sup>	20	20	20	80	03	25	25	150
AEC403	Theory of Machines- I <sup>§</sup>	20	20	20	80	03	25	--	125
AEC404	Production Process- II <sup>§</sup>	20	20	20	80	03	--	--	100
AEC405	Material Technology <sup>§</sup>	20	20	20	80	03	25	--	125
AEC406	Industrial Electronics <sup>§</sup>	20	20	20	80	03	25	25	150
AEL407	Machine Shop Practice- II <sup>§</sup>	--	--	--	--	--	50	25	75
<b>Total</b>		<b>--</b>	<b>--</b>	<b>120</b>	<b>480</b>	<b>--</b>	<b>150</b>	<b>75</b>	<b>825</b>

<sup>@</sup> Course common to Mech/Auto/Prod/Civil, <sup>§</sup> Courses common to Mech/Auto

Course Code	Course/Subject Name	Credits
<b>AEC401</b>	<b>Applied Mathematics –IV<sup>@</sup></b>	<b>4</b>

**Objectives:**

1. To inculcate an ability to relate engineering problems to mathematical context.
2. To provide a solid foundation in mathematical fundamentals required to solve engineering problem.
3. To study the basic principles of Vector analyses, statistics and probability and complex integration.
4. To prepare students for competitive exams.

**Outcomes:** Learner should be able to ....

1. Use matrix algebra with its specific rules to solve the system of linear equations.
2. Understand and apply the concept of probability distribution and sampling theory to engineering problems.
3. Apply principles of vector differential and integral calculus to the analysis of engineering problems.
4. Identify, formulate and solve engineering problems.

Module	Details	Hrs
<b>1</b>	<p><b>Matrices</b></p> <p>1.1 Brief revision of vectors over a real field, inner product, norm, Linear Dependence and Independence and orthogonality of vectors.</p> <p>1.2 Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof) Functions of a square matrix, Minimal polynomial and Derogatory matrix.</p>	<b>09</b>
<b>2</b>	<p><b>Vector calculus</b></p> <p>2.1 Brief revision of Scalar and vector point functions, Gradient, Divergence and curl.</p> <p>2.2 Line integrals, Surface integrals, Volume integrals. Green's theorem(without proof) for plane regions and properties of line integrals, Stokes theorem(without proof), Gauss divergence theorem (without proof) related identities and deductions.(No verification problems on Stoke's Theorem and Gauss Divergence Theorem)</p>	<b>11</b>
<b>3</b>	<p><b>Non Linear Programming</b></p> <p>3.1 Unconstrained optimization, problems with equality constraints Lagranges Multiplier method.</p> <p>3.2 Problem with inequality constraints Kuhn-Tucker conditions.</p>	<b>06</b>
<b>4</b>	<p><b>Probability Distributions</b></p> <p>4.1 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance.</p> <p>4.2 Probability Distributions: Binomial, Poisson and Normal Distributions. For detailed study.</p>	<b>10</b>
<b>5</b>	<p><b>Sampling Theory</b></p> <p>5.1 Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples.</p> <p>5.2 Test of significance for Large samples: Test for significance of the</p>	<b>10</b>

	<p>difference between sample mean and population means, Test for significance of the difference between the means of two samples.</p> <p>5.3 Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test.</p> <p>5.4 Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)</p> <p>5.5 Chi-square distribution and its properties, Test of the Goodness of fit and Yate's correction.</p>	
<b>6</b>	<p><b>Correlation and Regression</b></p> <p>6.1 Correlation, Co-variance, Karl Pearson Coefficient of Correlation &amp; Spearman's Rank Correlation Coefficient (non-repeated &amp; repeated ranks )</p> <p>6.2 Regression Coefficients &amp; lines of regression</p>	<b>06</b>

<sup>@</sup> Course common with Mech/Auto/Prod/Civil

### Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

### Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

### Reference Books:

1. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
2. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
3. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
4. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Vector Analysis by Murray R. Spiegel, Shaum Series
7. Operations Research, Kantiswarup, Manmohan, P K Gupta, S. Chand & CO.

Course Code	Course/Subject Name	Credits
<b>AEC402</b>	<b>Fluid Mechanics<sup>\$</sup></b>	<b>4+1</b>

**Objectives:**

1. To understand fluid statics and fluid dynamics.
2. To understand application of energy equation in fluid flow.
3. To learn various flow measurement techniques.

**Outcomes:** Learner should be able to ....

1. Understand properties of fluids and classification of flows
2. Formulate and solve equations of the control volume for fluid flow systems
3. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces
4. Apply fundamentals of compressible fluid flows to relevant systems

Module	Details	Hrs
<b>1</b>	1.1 Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids 1.2 Fluid Statics: Definition of body and surface forces, Pascal's law, Basic hydrostatic equation, Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle	<b>6</b>
<b>2</b>	<b>2 Fluid Kinematics:</b> 2.1 Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field; Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two and three dimensional flows; Definition of control volume and control surface, Understanding of differential and integral methods of analysis 2.2 Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates, rotational and irrotational flows; Definition and equations for source, sink, irrotational vortex, circulation	<b>6</b>
<b>3</b>	<b>3 Fluid Dynamics:</b> 3.1 Integral equations for the control volume: Reynold's Transport theorem( with proof), equations for conservation of mass, energy and momentum, Bernoulli's equation and its application in flow measurement, pitot tube, venture, orifice and nozzle meters. 3.2 Differential equations for the control volume: Mass conservation in 2 and 3 dimension in rectangular and cylindrical co-ordinates, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation; Navier-Stokes equations( without proof) in rectangular cartesian co-ordinates; Exact solutions of Navier-Stokes Equations to viscous laminar flow between two parallel planes ( Couette flow and plane Poiseuille flow)	<b>12</b>
<b>4</b>	<b>4 Real fluid flows:</b> 4.1 Definition of Reynold's number, Laminar flow through a pipe ( Hagen-Poiseuille flow), velocity profile and head loss; Turbulent flows and theories of turbulence-Statistical theory, Eddy viscosity theory and Prandtl mixing length theory; velocity profiles for turbulent flows- universal velocity profile, 1/7 <sup>th</sup> power law; Velocity profiles for smooth and rough pipes 4.2 Darcy's equation for head loss in pipe( no derivation),Moody's diagram, pipes in series and parallel, major and minor losses in pipes	<b>8</b>
<b>5</b>	<b>5 Boundary Layer Flows:</b> 5.1 Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer,	<b>8</b>

	laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers, analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to control it, streamlined and bluff bodies 5.2 Aerofoil theory: Definition of aerofoil, lift and drag, stalling of aerofoils, induced drag	
6	<b>6 Compressible Fluid flow:</b> 6.1 Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Application of continuity, momentum and energy equations for steady state conditions; steady flow through nozzle, isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio 6.2 Normal shocks, basic equations of normal shock, change of properties across normal shock	8

<sup>s</sup> Courses common to Mech/Auto

**Term Work:** Any 8 experiments to be performed of which at least 6 experiments will be in Fluid Dynamics, Experiment no: 14 is desirable

**List of Experiments:**

1. Calibration of pressure gauge
2. Determination of pressure surge in pipes
3. Measurement of hydrostatic force on bodies/surfaces
4. Verification of Archimedes' Principle
5. Verification of Pascal's law
6. Calibration of venturimeter / orificemeter / nozzlemeter / pitot tube
7. Determination of friction factor for pipes
8. Determination of major and minor losses in piping systems
9. Verification of energy equation
10. Verification of momentum principle
11. Verification of Bernoulli's equation
12. Calculation of lift and drag in aerofoils
13. Determination of pressure profile over an aerofoil
14. Mini Project along with brief report in which a group of students (Max 4) will design/fabricate/assemble a unit to demonstrate any principle of fluid mechanics.

**Note:** Error analysis is recommended

Distribution of marks for Term work shall be as follows:

Laboratory work (experiments/assignments):	20 marks
Attendance (Theory and practicals):	05 marks

**Theory Examination:**

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

**Internal Assessment:**

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

**Practical/Oral examination:**

1. The distribution of marks for oral-practical examination shall be as follows:
  - i. Practical performance ..... 15 marks
  - ii. Oral ..... 10 marks
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

**Reference Books:**

1. Fluid Mechanics : Streeter and Wylie, McGraw Hill
2. Fluid Mechanics : F.M.White, McGraw Hill
3. Fluid Mechanics: K.L.Kumar
4. Introduction to Fluid Mechanics: Fox and McDonald
5. Introduction to Fluid Mechanics: James.A.Fay
6. Prandtl Essentials of Fluid Mechanics :Herbert Oertel(Ed)
7. Fluid Mechanics: B.M.Massey
8. Fluid Mechanics: Cengel and Cimbala
9. Mechanics of Fluids: Irving Shames
10. Advanced Fluid Dynamics: Muralidhar and Biswas
11. Fluid Mechanics and Hydraulics, S. K. Ukarande, Ane Books Pvt.Ltd.

Course Code	Course/Subject Name	Credits
<b>AEC403</b>	<b>Theory of Machines – I<sup>s</sup></b>	<b>4+1</b>

**Objectives:**

1. To provide basic concept of kinematics and kinetics of machine elements.
2. To study basics of power transmission.

**Outcomes:** Learner should be able to ....

1. Define various components of mechanisms.
2. Construct/Compose mechanisms to provide specific motion.
3. Draw velocity and acceleration diagrams of various mechanisms.
4. Construct CAM profile for the specific follower motion.
5. Select appropriate power transmission mechanism.

Module	Details	Hrs
1	<p><b>1.1 Kinetics of rigid bodies</b>            Mass M.I. about centroidal axis and about any other axis. Radius of Gyration. D'Alemberts Principle of Bodies under rotational motion about a fixed axis and plane motion. Application of motion of bars, Cylinders and spheres only.            Kinetics of Rigid Bodies: Work and Energy.            Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work Energy Principle and Conservation of Energy.</p> <p><b>1.2 Basic Kinematics:</b>            Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), Kutzbach criterion, Grubler's criterion.            Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions.</p>	08
2	<p><b>2.1 Special Mechanisms:</b>  <b>Straight line generating Mechanisms:</b>            Exact Straight Line Generating Mechanisms – Peaucellier's and Hart's            Approximate Straight Line Generating Mechanisms – Watt's, Grasshopper and Tchebicheff's.  <b>Offset slider crank mechanisms</b>, Pantograph. Hook joint- single and double  <b>Steering gear mechanisms</b> – Ackerman, Davis</p>	05
3	<p><b>3.1 Velocity Analysis of mechanisms (mechanisms up to 6 links).</b>            Velocity analysis by instantaneous center of rotation method (Graphical approach)            Velocity analysis by relative velocity method (Graphical approach)            Analysis is extended to find rubbing velocities at joints, mechanical advantage (Graphical approach).            Velocity analysis of low degree complexity mechanisms (Graphical approach). Auxiliary point method</p> <p><b>3.2 Velocity and Acceleration analysis of mechanism.</b>            Velocity and Acceleration – analysis by relative method (mechanisms up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach).</p>	13



<b>4</b>	<b>4. Cam Mechanisms:</b> 4.1 Cam and its Classifications. 4.2 Followers and its Classification. 4.3 Motion analysis and plotting of displacement-time, velocity-time, acceleration- time, jerk-time graphs for uniform velocity. UARM, SHM and Cycloid motions (combined motions during one stroke excluded). 4.4 Motion analysis of simple cams – R-R cam, D-R-R and D-R-D-R cam operating radial translating follower. 4.5 Pressure angle and method to control pressure angle 4.6 Layout of cam profiles.	<b>08</b>
<b>5</b>	<b>5. Flexible Connectors:</b> 5.1 Belt – Types of belts, velocity ratio, slip & creep, length of belt for open & cross system. Law of belting, Dynamic analysis- driving tensions, centrifugal tension, initial tension, condition of maximum power transmission. 5.2 Chains – types of chains, chordal action, variation in velocity ratio, Length of chain	<b>07</b>
<b>6</b>	<b>6. Gears</b> 6.1 Law of gearing, Involute and Cycloid gear tooth profile, Construction of Involute profile. 6.2 Path of contact, arc of contact, contact ratio for involutes and cycloidal tooth profile, Interference in involutes gears. Critical Numbers of teeth for interference free motion. Methods to control interference in involutes gears. 6.3 Static force analysis in gears- spur, helical, worm & worm wheel.	<b>07</b>

<sup>s</sup> Courses common to Mech/Auto

#### **Term Work:**

1. Velocity analysis by Instantaneous Center of Rotation- 3 to 5 Problems
2. Velocity analysis by relative method - 3 to 5 Problems
3. Velocity – Acceleration analysis by relative method - 3 to 5 Problems
4. Motion analysis and plotting of displacement-time, velocity-time, acceleration- time, jerk- time and Layout of cam profiles- 3 to 5 Problems
5. Construction of conjugate / involved profiles - 1 to 2 Problems
6. Mini Project on design and fabrication of any one mechanism for a group of maximum 4 students

Distribution of marks for Term work shall be as follows:

Laboratory work (experiments/assignments):	20 marks
Attendance (Theory and practicals):	05 marks

#### **Theory Examination:**

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) .

**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

**Internal Assessment:**

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

**Reference Books:**

1. Theory of Mechanisms and Machines By Amitabh Ghosh and A. Kumar Mallik.
2. Theory of Machines and Mechanism By John Uicker, Garden Pennock & Late. J. F. Shigley
3. Theory of Machines – P. L. Ballaney
4. Theory of Machines by S. S. Rattan
5. Kinematics of Machines By R T Hinckle (Prentice Hall Inc.)
6. Kinematics By V.M. Fairs (McGraw Hill)
7. Mechanism Design: Analysis and Synthesis Vol. I by A. Erdman and G.N. Sander (Prentice Hall)
8. Kinematics and Dynamics of Planer Mechanisms By Jeremy Hirsihham (McGraw Hill).

Course Code	Course/Subject Name	Credits
<b>AEC404</b>	<b>Production Process – II<sup>§</sup></b>	<b>4</b>

**Objectives:**

1. To study machine tools and basic machining processes.
2. To know the fundamentals of metal cutting and tool engineering.
3. To familiarize with modern machine tools.

**Outcomes:** Learner should be able to ....

1. Understand chip forming processes such as turning, milling, drilling, etc.
2. Understand the design aspects of cutting Tools and Economics of machining.
3. Distinguish between the conventional and modern machine tools.

Module	Details	Hrs
1	<b>Classification, Selection and application of Machine Tools:</b> 1.1 Lathe Machines, Milling Machines, Drilling Machines, Grinding Machines, Broaching machines, Lapping/Honing machines and shaping/slotting/planning Machines. 1.2 Gear Manufacturing -Gear milling, standard cutters and limitations, gear hobbing, gear shaping, gear shaving and gear grinding processes.	12
2	<b>CNC machines:</b> Introduction, principles of operation, Types – Vertical machining centers and horizontal machining centers, major elements, functions, applications, controllers, open loop and closed loop systems, coordinate measuring machines, maintenance of CNC machines, G, M Codes, Basic CNC programming	06
3	<b>Metal Cutting &amp; Tool Engineering:</b> Features of machining processes, concept of speed and cutting, mechanism of chip formation, concept of shear plane, chip reduction coefficient force analysis. Merchant's circle of cutting forces, expression for shear plane angle and coefficient of friction in terms of cutting forces and tool angles. Merchant's theory-original and modified cutting force and power calculation in machining processes, gross power, efficiency of machine tools, effect of various parameters on cutting forces, methods of estimating of cutting forces.	08
4	<b>Measurement of Tool Forces and Economics of metal cutting:</b> Different types of dynamometers and their operations. Tool life definition, mechanism of tool wear and measurement, preliminary and ultimate feature, factors influencing tool life such as speed, feed, depth of cut, tool material, cutting fluids etc. Machinability, Economics of metal cutting:-parameters affecting machining cost. Tool life for minimum cost and for maximum productivity.	08
5	<b>Surface Finish, Cutting Tool Materials, Coolants:</b> Surface finish-influence of various parameters cutting tool materials-composition, field of application and manufacture.(carbon tool steel, high speed steel, non-ferrous alloys, carbides and ceramics), Selection of grinding wheel and dressing & truing of grinding wheels, coolants –function of coolants, effects on cutting force, tool life and surface finish, Types of coolants, Choice of coolants.	06
6	<b>Design of Cutting Tools or Tool design:</b> Tool geometry and definition of principles tool angles of single point cutting tools, Design of single point cutting tools, Form tools, Drills, Milling cutters, Inserted type cutters, Broach tools, Standard inserts and Holders for Turning.	12

<sup>§</sup> Courses common to Mech/Auto

**Theory Examination:**

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

**Internal Assessment:**

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

**Reference Books:**

1. Tool Design by Donaldson.
2. Machining Process by H.L. Juneja
3. Production Technology - HMT
4. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R. Schmid, published by Prentice Hall
5. Fundamentals of Tool Design by ASTME
6. Metal cutting Theory & Cutting Tool Designing by V. Arshinov, G Alekseev
7. Principle of Metal cutting by Sen & Bhattacharya
8. Fundamentals of Metal Machining by Geoffery Boothroyd
9. Manufacturing science by Ghosh and Mallick.

Course Code	Course/Subject Name	Credits
<b>AEC405</b>	<b>Material Technology<sup>s</sup></b>	<b>3+1</b>

**Objectives:**

1. To study basic engineering materials, their properties, applications & selection.
2. To study types and causes of failure of components in service.

**Outcomes:** Learner should be able to ....

1. Identify various defects and failure mechanisms.
2. Interpret Iron-Iron carbide diagram, TTT diagram & their significance.
3. Select appropriate heat treatment process for specific requirements.
4. Understand effect of alloying elements on properties.

Module	Details	Hrs
1	<p><b>Classification of Materials:</b> Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples.</p> <p><b>Lattice Imperfections:</b> Definition, classification and significance of Imperfections Point defects: vacancy, interstitial and impurity atom defects. Their formation and effects. Dislocation: Edge and screw dislocations Burger's vector. Motion of dislocations and their significance. Surface defects: Grain boundary, sub- angle grain boundary and stacking faults. Their significance. Generation of dislocation. Frank Reed source, conditions of multiplication and significance.</p> <p><b>Deformation:</b> Definition, elastic and plastic deformation, Mechanism of deformation and its significance in design and shaping, Critical Resolved shear stress. Deformation in single crystal and polycrystalline materials Slip systems and deformability of FCC, BCC and HCP lattice stems.</p> <p><b>Strain Hardening:</b> Definition importance of strain hardening. Dislocation theory of strain hardening, Effect of strain hardening on engineering behaviour of materials. Recrystallization Annealing: stages of recrystallization annealing and factors affecting it</p>	8
2	<p><b>Failure mechanisms:</b></p> <p><b>Fracture:</b> Definition and types of facture, Brittle fracture: Griffith's theory of facture. Orowan's modification. Dislocation theory of facture. Critical stress and crack propagation velocity for brittle fracture. Ductile fracture: Notch effect on fracture. Fracture toughness. Ductility transition. Definition and signification. Conditions of ductility transition factors affecting it.</p> <p><b>Fatigue Failure:</b> Definition of fatigue and significance of cyclic stress. Mechanism of fatigue and theories of fatigue failure, Fatigue testing. Test data presentation and statistical evolution. S-N Curve and its interpretation. Influence of important factors on fatigue. Notch effect, surface effect, Effect of pre-stressing, corrosion fatigue, Thermal fatigue.</p> <p><b>Creep:</b> Definition and significance of creep. Effect of temperature and creep on mechanical behaviors of materials. Creep testing and data presentation &amp;</p>	8

	analysis. Mechanism and types of creep. Analysis of classical creep curve and use of creep rate in designing of products for load bearing applications. Creep Resistant materials.	
3	<p><b>Theory of Alloys &amp; Alloys Diagrams :</b></p> <p>Significance of alloying, Definition, Classification and properties of different types of alloys. Different types of Phase diagrams (Isomorphous, Eutectic, Peritectic, Eutectoid, Peritectoid) and their analysis. Importance of Iron as engineering material, Allotropic forms of Iron, Influence of carbon in Iron-Carbon alloying</p> <p>Iron-Iron carbide diagram and its analysis, TTT diagram, Hardenability concepts and tests, Graphitization of Iron- Grey iron, white iron, Nodular and malleable irons. Their microstructures, properties and applications</p>	8
4	<p><b>Heat treatment Process:</b></p> <p>Technology of heat treatment. Classification of heat treatment process.</p> <p>Annealing- Principle process, properties and applications of full annealing, Diffusion annealing, process annealing and Cyclic annealing, Normalizing, Hardening heat treatment. Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process.</p> <p>Surface hardening: Hardening and surface Hardening methods. Their significance and applications. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes</p>	6
5	<p><b>Effect of Alloying Elements in Steels:</b></p> <p>Limitation of plain carbon steels. Significance of alloying elements.</p> <p>Effects of major and minor constituents, Effect of alloying elements on ferrite, carbide, austenite, Effect of alloying elements on phase transformation</p> <p>Classification of tool steels and metallurgy of tool steels and special steels</p>	4
6	<p><b>Introduction to New materials:</b></p> <p>Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications.</p> <p>Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and nano composites.</p> <p>Polymers: Basic concepts, Processing methods, advantages and disadvantages over metallic materials, examples and applications.</p>	4

<sup>s</sup> Courses common to Mech/Auto

### Term Work:

#### List of Experiment: Minimum eight experiments

1. Study of metallurgical microscope.
2. Metallographic sample preparation and etching.
3. Microstructures of plain carbon steels.
4. Microstructures of cast irons.
5. Fatigue test – To determine number of cycles to failure of a given material at a given stress.
6. Annealing, Normalising and Hardening of medium carbon steel and observation of microstructures.
7. Study of tempering characteristics of hardened steel.
8. Determination of hardenability of steel using Jominy end Quench Test.
9. Corrosion rate test

The distribution of marks for term work shall be as follows:

Laboratory work (assignments/Experiments/seminar report):	20 Marks.
Attendance (Theory and practical's):	05 marks

### **Theory Examination:**

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

### **Internal Assessment:**

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

### **Reference Books:**

1. Materials Science and Engineering by William D. Callister, Jr. – Adapted by R. Balasubramaniam. Wiley India (P) Ltd.
2. The Structure and Properties of Materials Vol I: M. G. Moffet, G. T. W. Pearsall & J. Wulff.
3. Material Science and Metallurgy, By V.D. Kodgire.
4. Metallurgy for Engineer- E.C. Rollason - ELBS SOC. And Edward Arnold, London.
5. Mechanical Behaviour of Materials- Courtney- McGraw Hill International New Delhi.
6. Introduction of Engineering Materials, By B.K. Agrawal, McGraw Hill Pub. Co. ltd
7. Mechanical Metallurgy: G.E. Dieter , McGraw Hill International New Delhi.
8. Metallurgy Engineering Part I&II-R. A. Higgins & Hodder Stoughton, London.
9. A text book of Metallurgy- A.R.Bailey – Macmillan & Co. Ltd., London.
10. Introduction to solids- L.V.Azaroff- McGraw Hill International New Delhi.
11. The Structure and Properties of Engineering Alloys- W.F. Smith- McGraw hill Int.
12. Strengthening of Metals Packner - Reinhild Pupliching Corporation, New Delhi.
13. Engineering Physical Metallurgy, By Y. Lakhtin , Mir Publishers, Moscow.
14. Physical Metallurgy for Engineers, By Donald S. Clarke and Wibur R. Varney, D. Van Nostrand Co.INC.
15. Engineering Metallurgy Part I & II, By Raymond A. Higgins, English Language Book Society &Hodder & Stragton.
16. A text book of Metallurgy, By A.R.Bailey Mc Millan & ltd ,London.
17. Structure and Properties of Alloys, By Robert M, Brick, Robert B, Gordon , McGraw Hill International Book Co.
18. Metallurgy for Engineers, By E.C. Rollason, English Language Book Society &Edward Arnold Publisher Ltd.
19. The Science and Engineering of Materials, By Donald R. Askeland- PWS Publishing Co. Physical Metallurgy by Avner
20. M.G. Fontana, Corrosion Engineering, 3<sup>rd</sup> Ed., McGraw-Hill

Course Code	Course/Subject Name	Credits
<b>AEC406</b>	<b>Industrial Electronics<sup>s</sup></b>	<b>3+1</b>

**Objectives:**

1. To learn industrial electronics in applied manner with perspective of mechanical engineering.
2. To introduce the design philosophy for mechanical processes control based on analog and digital electronics and electrical machines.

**Outcomes:** Learner should be able to ....

1. Understand the applications of power electronic converters.
2. Understand concept of OPAMP.
3. Demonstrate the knowledge of basic functioning of digital circuits and microcontrollers.
4. Understand speed-torque characteristics of electrical machines for implementation of speed control methods using electrical drives.

Modules	Details	Hrs
1	<p><b>Semiconductor Devices:</b>  <b>Review of diodes: rectifier diode , zener diode, LED, photodiode</b>            SCR V-I characteristics , R,R-C,UJT triggering circuits, turning-off of a SCR (preliminary discussion), basics of Gate Turn Off ( GTO )            Structure and V-I characteristics of Triac (modes of operation not needed) and Diac , Applications of Triac-Diac circuit,            Characteristics and principle of Power BJT, power MOSFET, IGBT, comparison of devices</p>	6
2	<p><b>Phase controlled rectifiers and Bridge inverters:</b>            Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only. Derivation of output voltage, Concept of R-L and R-L-E load,            Block diagram of closed loop speed control of DC motors, Necessity of inner current control loop, current sensing            Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors(frequency control only)</p>	8
3	<p><b>Operational amplifiers and 555 Timer:</b>            Operational amplifier circuits, Ideal OPAMP behavior , common OPAMP ICs, Basic OPAMP circuits- Inverting amplifier, Noninverting amplifier ,Voltage follower (Buffer), Instrumentation Amplifier, Summing amplifier, Schmitt triggers            Active first order filter: Low pass and high pass filter            Power Op Amps, Optical Isolation amplifier            555 timer-Operating modes: monostable, astable multivibrator</p>	4
4	<p><b>Digital logic and logic families:</b>            Digital signals, combinational and sequential logic circuits, clock signals, Boolean algebra and logic gates            Integrated circuits and logic families : Logic Levels, Noise Immunity, Fan Out, Power Dissipation, Propagation Delay,            TTL logic family : TTL Designations, TTL Versions, Output Configuration, TTL characteristic, The CMOS family,, comparison with TTL family            Flip flops: Set Reset(SR),Trigger(T),clocked D F/Fs; Buffer and drivers            Registers, decoders and encoders, Multiplexer and Demultiplexer</p>	5



5	<b>Microprocessor and Microcontrollers:</b> Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller, MSP430 Functional block diagram and architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output)	8
6	<b>Motors:</b> Review and comparison of Torque–speed characteristics of DC motors and AC induction motors. Basic principles of speed control of AC/DC motors Basics of BLDC motor, Linear Actuator motor, Servo Motor Suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools etc.	5

<sup>s</sup> Courses common to Mech/Auto

### Term Work:

**List of Experiment: Minimum six out of 1-9 and four from 10-15. (Total ten experiments)**

1. BJT as a switch
2. V-I characteristics of SCR
3. Triggering circuit of SCR (R,RC,UJT)
4. Full wave Rectifier using SCR
5. Single phase Bridge inverter with rectifier load
6. OPAMP as integrator
7. 555 timer as astable multivibrator
8. Implementing study of gates and Logic Operations like , NOT, AND, OR,
9. Realization of basic gates using universal gates
10. Light dimmer circuit using Diac-Triac
11. Characteristics of DC shunt motor
12. Speed control of DC motor
13. Speed control of induction motor
14. Simple programs using microcontroller
15. Simple programs for microcontroller based applications

Distribution of marks for Term work shall be as follows:

Laboratory work (experiments/assignments):	20 marks
Attendance (Theory and practicals):	05 marks

### Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

**In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

### Internal Assessment:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

**Practical/Oral examination:**

1. The distribution of marks for oral-practical examination shall be as follows:
  - i. Practical performance ..... 15 marks
  - ii. Oral ..... 10 marks
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

**Reference Books:**

1. Power Electronics M.H.Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics ---Vedam Subramanyam, New Age International
4. Jain R.P., "Modern Digital Electronic" Tata McGraw Hill, 1984.
5. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
6. Electrical drives by G K Dubey, Narosa publications
7. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
8. Digital principal and Application, Malvino & Leach, Tata McGraw Hill, 1991.
9. Digital design, Morris M. Mano, Prentice Hall International – 1984.
10. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall of India.
11. Electronic Devices and Circuits, Millman and Halkias, Tata McGraw-Hill.
12. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition (September 4, 2008)

Course Code	Course/Subject Name	Credits
<b>AEL407</b>	<b>Machine Shop Practice – II<sup>§</sup></b>	<b>2</b>

**Objectives:**

1. To understand basic machining processes.
2. To understand various machining operations and machine protocols.

**Outcomes:** Learner should be able to ....

1. Operate various machines like lathe, shaper, grinding machine, milling machine etc.
2. Perform precision turning, boring etc.

Module	Details	Hrs
	One composite job consisting minimum four parts employing operations on lathe like precision turning screw cutting, boring etc.  This job shall involve use of shaping, milling and grinding operations	<b>48</b>

<sup>§</sup> Courses common to Mech/Auto

**Term Work:**

1. Composite job mentioned above
2. Complete Work-Shop Book which give details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book	.....	40 marks
Attendance (Practicals)	.....	10 marks

**Practical Examination:**

Practical examination will be held for 4 hours. Job shall consist of minimum four operations such as precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.