

UNIVERSITY OF MUMBAI



Revised Syllabus

Program- Bachelor of Engineering

Course - Automobile Engineering

(Second Year – Sem. III & IV)

Under

FACULTY OF TECHNOLOGY

(As per Credit Based Semester and Grading System from 2013-14)

Deans Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande

Dean,

Faculty of Technology,

Member - Management Council, Senate, Academic Council

University of Mumbai, Mumbai

Chairman Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of University of the Mumbai, I am happy to state here that, the Program Educational Objectives were finalized in a brain storming session, which was attended by more than 20 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Automobile Engineering. The Program Educational Objectives finalized for the undergraduate program in Automobile Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To prepare the Learner to use modern tools effectively in order to solve real life problems.
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and to excel in their Postgraduate studies.
4. To encourage and motivate the Learner in the art of self-learning.
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to the above, 2 to 3 more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from the point of view of a learner are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stake holders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for B E Automobile Engineering

S. E. (Mechanical/Automobile) Sem.- III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.		Theory	Pract.	Total		
AEC301	Applied Mathematics III [®]	4	--		4	--	4		
AEC302	Thermodynamics [§]	4	--		4	--	4		
AEC303	Strength of Materials [§]	4	2		4	1	5		
AEC304	Production Process- I [§]	4	--		4	--	4		
AEL305	Computer Aided M/c Drawing ⁺	--	2*+4		-	3	3		
AEL306	Data Base & Information Retrieval System [#]	--	2*+2		-	2	2		
AEL307	Machine Shop Practice- I [§]	--	4		--	2	2		
Total		16	16		16	8	24		
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.					
AEC301	Applied Mathematics III [®]	20	20	20	80	03	--	--	100
AEC302	Thermodynamics [§]	20	20	20	80	03	--	--	100
AEC303	Strength of Materials [§]	20	20	20	80	03	25	--	125
AEC304	Production Process- I [§]	20	20	20	80	03	--	--	100
AEL305	Computer Aided M/c Drawing ⁺	--	--	--	--	--	50	50	100
AEL306	Data Base & Information Retrieval System [#]	--	--	--	--	--	50	50	100
AEL307	Machine Shop Practice- I [§]	--	--	--	--	--	50	--	50
Total		--	--	80	320	--	175	100	675

* Theory for entire class to be conducted, [®] Course common to Mech/Auto/Prod/Civil, ⁺ Course common to Mech/Auto/Prod, [#] Course common to Mech/Auto/Prod/Civil, [§] Courses common to Mech/Auto

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 [®]	4	--		4	--	4		
AEC402	Fluid Mechanics [§]	4	2		4	1	5		
AEC403	Theory of Machines- I [§]	4	2		4	1	5		
AEC404	Production Process- II [§]	4	--		4	--	4		
AEC405	Material Technology [§]	3	2		3	1	4		
AEC406	Industrial Electronics [§]	3	2		3	1	4		
AEL407	Machine Shop Practice- II [§]	--	4		--	2	2		
Total		22	12		22	6	28		
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 [®]	20	20	20	80	03	--	--	100
AEC402	Fluid Mechanics [§]	20	20	20	80	03	25	25	150
AEC403	Theory of Machines- I [§]	20	20	20	80	03	25	--	125
AEC404	Production Process- II [§]	20	20	20	80	03	--	--	100
AEC405	Material Technology [§]	20	20	20	80	03	25	--	125
AEC406	Industrial Electronics [§]	20	20	20	80	03	25	25	150
AEL407	Machine Shop Practice- II [§]	--	--	--	--	--	50	25	75
Total		--	--	120	480	--	150	75	825

[®] Course common to Mech/Auto/Prod/Civil, [§] Courses common to Mech/Auto

Course Code	Course/Subject Name	Credits
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AEC301	Applied Mathematics –III[@]	4
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Objectives:

1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series, Complex Variables.

Outcomes: Learner should be able to

1. Demonstrate the ability of using Laplace Transform and Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations.
2. Identify the analytic function, harmonic function, orthogonal trajectories and to apply bilinear transformations and conformal mappings.
3. Identify the applicability of theorems and evaluate the contour integrals.

Module	Details	Hrs
1	<p>Laplace Transform</p> <p>1.1 Function of bounded variation, Laplace Transform of standard functions such as $1, t^n, e^{at}, \sin at, \cos at, \sinh at, \cosh at$</p> <p>1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof)</p> <p>$L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Heaviside Unit step function, Dirac Delta function, Periodic functions and their Laplace Transform.</p>	6
2	<p>Inverse Laplace Transform</p> <p>2.1 Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem.</p> <p>2.2 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable.</p>	5
3	<p>Complex variables:</p> <p>3.1 Functions of complex variable, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates.</p> <p>3.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories.</p> <p>3.3 Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation.</p>	10
4	<p>Complex Integral</p> <p>4.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic function, Cauchy's Goursat theorem (without proof), properties of line integral, Cauchy's integral formula and deductions.</p> <p>4.2 Singularities and poles:</p> <p>4.3 Taylor's and Laurent's series development (without proof)</p> <p>4.4 Residue at isolated singularity and its evaluation.</p> <p>4.5 Residue theorem, application to evaluate real integral of type</p> $\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x) dx$	10
5	<p>Fourier Series</p> <p>5.1 Orthogonal and orthonormal functions, Expressions of a function in a</p>	10

	<p>series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π & $2l$.</p> <p>5.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series, Parsvel's identities (without proof)</p> <p>5.3 Complex form of Fourier series.</p>	
6	<p>Partial Differential Equations</p> <p>4.1 Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method(Crank- Nicolson method) Successive over relaxation method.</p> <p>4.2 Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series.</p> <p>4.3 Heat equation, steady-state configuration for heat flow.</p> <p>4.4 Two and Three dimensional Laplace equations.</p>	10

@ 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. Elements of Applied mathematics, P N & J N Wartikar, Pune VidyarthiGruhaPrakashan
2. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
4. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
5. Complex Variables: Churchill, Mc-Graw Hill
6. Numerical Methods, Kandasamy, S. Chand & CO.

Course Code	Course/Subject Name	Credits
AEC302	Thermodynamics^s	4

Objectives:

1. To understand the concepts of Energy in general and Heat and Work in particular.
2. To understand the fundamentals of quantification and grade of energy.
3. To apply the concepts of thermodynamics to basic energy systems.

Outcomes: Learner should be able to

1. Demonstrate understanding of basic concepts of thermodynamics.
2. Differentiate between quality and quantity of energy, heat and work, enthalpy and entropy, etc.
3. Analyze basic power cycles.
4. Apply the laws of thermodynamics to various real life systems.

Module	Details	Hrs
1	<p>Introduction and Basic Concepts: Application areas of thermodynamics, Systems and Control volumes, Properties of system, Continuum, State and equilibrium, Processes and cycles, Temperature and Zeroth law of thermodynamics, Heat and thermodynamic concept of work.</p> <p>First Law of Thermodynamics: Statement, Heat and work calculations, Application of first law to non-flow and flow systems, steady flow energy equation as applied to boiler, condenser, nozzle and turbine.</p>	8
2	<p>Second Law of Thermodynamics: Statements and their equivalence, thermal energy reservoirs, concept of heat engine, refrigerator, heat pump and perpetual motion machines, Carnot cycle and principles.</p> <p>Entropy: Concept of entropy, Temperature- entropy plot, Clausius inequality theorem, Principle of Increase of entropy, entropy balance, entropy generation in daily life, first and second law combined, entropy changes of an ideal gas during reversible processes.</p>	8
3	<p>Availability: Available and unavailable energy, Available energy (AE) referred to cycle and energy source, Availability in steady flow process, availability in non-flow process, Irreversibility, Definition of second law efficiency.</p> <p>Property Relations: Introduction to Maxwell relations, ClausiusClapeyron equation, volume expansivity and isothermal compressibility, Mayer relation, Joule-Thomson coefficient.</p>	8
4	<p>Properties of Steam: Dryness fraction, enthalpy, internal energy and entropy, steam table and Mollier chart, First law applied to steam processes.</p> <p>Vapour Power Cycles: Carnot vapour cycle, Rankine cycle, Ideal reheatRankine cycle, Introduction to cogeneration.</p>	8
5	<p>Gas Power Cycles: Air standard assumptions, Otto cycle, Diesel cycle, dual cycle, Stirling cycle, Ericsson cycle, Atkinson cycle, Brayton cycle.</p>	8
6	<p>Reactive Systems:</p>	8

	Combustion, theoretical and actual combustion processes, enthalpy of formation and enthalpy of combustion, Adiabatic flame temperature, first law analysis of reactive system.	
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^s 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 mentioned 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. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A Boles,7e, TMH.
2. Engineering Thermodynamics- A Generalized Approach by P L Dhar, ELSEVIER
3. Thermodynamics by P K Nag, TMH, 5TH Edition
4. Modern Engineering Thermodynamics by Robert T Balmer, ELSEVIER
5. Thermodynamics and Heat Engines by R Yadav, Central Publishing house.
6. Thermodynamics by Onkar Singh, New Age International
7. Thermal Engineering by Mahesh Rathod, McGrawHill Publications
8. Thermodynamics by C P Arora, TMH
9. Thermodynamics by R K Rajput, Laxmi Publications.
10. Schaum's Outlines: Thermodynamics for Engineers by Merle C. Potter
11. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press (India) Pvt Lt.
12. Fundamentals of Thermodynamics by Moran & Shapiro.
13. Basic Engineering Thermodynamics by Rayner Joel, Longman Publishers
14. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., John Wiley & Sons.
15. Thermodynamics by W.C. Reynolds, , McGraw-Hill & Co.
16. Holman, J.P. Thermodynamics. McGraw- Hill
17. Basic Engineering \thermodynamics by Zemanski and Van ness, TMH

Course Code	Course/Subject Name	Credits
AEC303	Strength of Materials^s	4+1

Objectives:

1. To gain knowledge of different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. To study the distribution of various stresses in the mechanical elements such as beams, shafts etc.
3. To study Effect of component dimensions and shape on stresses and deformations.

Outcomes:Learner should be able to

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw SFD and BMD for different types of loads and support conditions.
3. Compute and analyze stresses induced in basic mechanical components.
4. Analyze buckling and bending phenomenon in columns and beams respectively.

Module	Details	Hrs
1	<p>Moment of Inertia: Mass Moment of Inertia , Area Moment Of Inertia, Parallel Axis theorem, Polar Moment of Inertia, Principle axes, Principle moment of inertia</p> <p>Stress and Strain: Definition, Stress- strain, uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress-Elastic limit, Hooke's Law.</p> <p>Elastic Constants: Poisson's Ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, Yield stress, Ultimate stress.</p> <p>Factor of safety, state of simple shear, relation between elastic constants, Volumetric Strain, Volumetric strain for tri-axial loading, Deformation of tapering members, Deformation due to self-weight, bars of varying sections, composite sections,</p> <p>Thermal Stress:</p>	12
2	<p>Shear Force and Bending Moment in Beams: Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force & bending moment.</p>	8
3	<p>Stresses in Beams: Theory of pure Bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, Section moduli for different sections, beams for uniform strength, Flitched beams</p> <p>Direct & Bending Stresses: Core of Section, Chimneys subjected to wind pressure</p> <p>Shear Stress in Beams: Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.</p>	8
4	<p>Torsion: Torsion of circular shafts-solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel.</p> <p>Strain Energy: Resilience, proof Resilience, strain energy stored in the member due to gradually applies load, suddenly applied load, impact load. Strain energy stored due to Shear, Bending and Torsion.</p>	8

5	Deflection Of Beams: Deflection of Cantilever, simply supported and over hanging beams using double integration and Macaulay's Method for different type of loadings. Thin Cylindrical and Spherical Shells: Cylinders and Spheres due to internal pressure. Cylindrical Shell with hemispherical End.	8
6	Columns and Struts: Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine- Gordon Formula	4

^s Courses common to Mech/Auto

Term Work:

List of Experiment:

1. Tension test on mild steel bar (stress - strain behavior, modulus determination)
2. Test on-tor-steel bar
3. Torsion test on mild steel bar/cast iron bar
4. Brinell hardness test
5. Rockwell hardness test
6. Izod impact test / Charpy test
7. Flexural test on beam (central point load)
8. Flexural test on beam (two point load)

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. Strength of Materials, Subramanyam, Oxford University Press, Edition 2005
2. Mechanics of Materials, B.C Punmia Ashok Jain, Arun Jain, Lakshmi Publications, NewDelhi.
3. Strength of Materials, Basavarajaiah and MahadevappaKhanna Publishers, New Delhi.
4. Strength of Materials, Singer Harper and Row Publications
5. Elements of Strength of Materials, Timoshenko and Young Affiliated East-West Press.
6. Mechanics of Materials, James M. Gere (5th Edition), Thomson Learning
7. Strength of Materials—S. Ramamrutham, Dhanpat Rai Pvt. Ltd.
8. Mechanics of Materials—S. S. Rattan, TMH Pvt. Ltd.
9. Mechanics of Structures—S. B. Junnarkar, Charotar Publication.
10. Strength of Materials—W. Nash, Schaum's Outline Series, McGraw Hill Publication.

Course Code	Course/Subject Name	Credits
AEC304	Production Process – I^s	4

Objectives:

1. To study basic production processes.
2. To study how to select appropriate production processes for a specific application.
3. To know the fundamentals of non-destructive testing.

Outcomes: Learner should be able to

1. Demonstrate understanding of non-chip forming processes such as casting, forging, metal joining, etc.
2. Understand basics of powder metallurgy.
3. Identify the role of Non Destructive Techniques in production processes.

Module	Details	Hrs
1	Classification of Production Processes: Examples and field of applications Metal Casting Process: Fundamentals of metal casting, Pattern materials and types of Patterns for casting, Types of Casting (like sand, shell-mold, CO ₂ mold casting, Cold box, Hot box, Investment, vacuum, pressure, die, centrifugal, etc.), Design considerations, Inspection of castings, Casting defects.	10
2	Forming Processes: Principles and process characteristics, Rolling types and capacities, Rolling parameters: Draught, spread, elongation ,roll pressure, torque, work and power in rolling., Effect of front and back tension on rolling load, Principles of roll pass. Miscellaneous processes like thread rollingroll forging, production of seamless tube by rolling, defects in rolled products. Forging (basic principles, machines, types etc), extrusion and wire drawing	08
3	Welding and Joining Processes: Mechanical fastening (Riveting), adhesive bonding, soldering and brazing. Welding Introduction, Fusion welding, gas and arc welding, submerged arc welding, inert gas welding, Electric slag welding, Carbon-dioxideshielded welding, thermit welding, Pressure welding, solid phase welding, resistance welding, and friction welding. Welding Equipment, process capability of welding its and applications. Weld joints- types, edge preparations. Weldability – designs, process and metallurgical considerations – testing and improvement of weldability – microstructure of weld – welding defects, advancements in welding.	16
4	Powder Metallurgy: like sintering and metal injection molding: Principle, process, applications, advantages and disadvantages of powder metallurgy, Processes of powder making and mechanisms of sintering.	06
5	Moulding with polymers: Basic concepts related to Injection Molding, Compression moulding, Transfer moulding, Blow Molding, Rotational Molding, Thermoforming and Extrusion.Applications of plastics in Engineering field. Moulding with ceramics: Blow moulding and extrusion of glass.	06
6	Non Destructive Techniques: Dye Penetrant, Magnetic, Electrical, Ultrasonic and Radiographic non-destructive testing methods.	04

^s 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.

ReferenceBooks:

1. Workshop Technology By W. A. J. Chapman part I, II & III
2. A Textbook of Foundry Technology by M. Lal
3. Production Technology by R. C. Patel and C. G. Gupta Vol I, II.
4. Production Technology by Jain & Gupta.
5. Manufacturing, Engineering and Technology SI by SeropeKalpakjian, Steven R. Schmid, published by Prentice Hall
6. Introduction to manufacturing processes by John A. Schey, published by McGraw-Hill
7. Manufacturing Processes & Materials for Engineers by Doyle.
8. Production Technology by HMT.
9. Production Technology by Raghuvanshi
10. Elements of Workshop Technology HazraChaudharyVol I, II.
11. Foundry technology by P.L. Jain .
12. Manufacturing processes by P. N. Rao, Vol. 1 and 2.
13. ASME Handbook Vol. 15 and 16.
14. Welding Technology by Little

Course Code	Course/Subject Name	Credits
AEL305	Computer Aided Machine Drawing⁺	3

Objectives:

1. To gain insight of visualizing an object and convert it into a drawing.
2. To gain knowledge of conventional representation of various machining and mechanical details as per IS.
3. To become conversant with 2-D and 3-D drafting.

Outcomes:Learner should be able to....

1. Visualize and prepare detail drawing of a given object.
2. Draw details and assembly of mechanical systems.
3. Read and interpret a given drawing.
4. Create 2-D and 3-D models using standard CAD software with manufacturing considerations.

Mod ule	Details	Hrs.	
		Theo ry	Practi cal
1	1.1 Solid Geometry: Intersection of surfaces and interpenetration of solids- Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only. Primary auxiliary views and auxiliary projections of simple machine parts.	08	--
	1.2 Machine Elements: Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc.)	--	04
	1.3 Conventional representation of assembly of threaded parts in external and sectional views, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components.	01	--
2	2.1 Limits fits and tolerances: Dimensioning with tolerances indicating various types of fits in details and assembly drawings, Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards.	04	--
	2.2 Details and assembly drawing: Introduction to the unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Sequence in assembly.	02	--
	2.3 Preparation of details and assembly drawings of <i>any two</i> from: Clapper block, Single tool post, Lathe and Milling tail stock.	--	05
	2.4 Cotter, Knuckle joint, Keys and Couplings: keys-sunk, parallel woodruff, saddle, feather etc. Coupling: simple, muff, flanged.	03	--
	2.5 Protected flange coupling, Oldham's coupling, Universal coupling.	--	06
3	3.1 Preparation of details and assembly drawings of Bearings: Simple, solid, Bushed bearing. I.S. conventional representation of ball and roller bearing.	01	--
	3.2 Pedestal bearing, footstep bearing	--	04
4	4.1 Preparation of details and assembly drawings of pulleys, Pipe joints: ClassificationofPulleys, pipe joints	02	--
	4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.	--	05
	4.3 Pipe joints (<i>any two</i>): Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint.	--	06
5	5.1 Preparation of details and assembly drawings of Valves, I.C.	02	--

	Engine parts: Types of Valves, introduction to I.C. Engine 5.2 Preparation of details and assembly drawings of(<i>any three</i>): Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft, Carburetor, Fuel pump, injector, and Spark plug.	--	08
6	6.1 Preparation of details and assembly drawings of Jigs and Fixtures: Introduction to Jigs and fixtures,	01	--
	6.2 Jigs and Fixtures (<i>any two from each</i>)	--	06
	6.3 Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, sketch the minimum views required for each component, measure all the required dimensions of each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions	--	04

*Course common with Mech/Auto/Prod

Term work:

- A. Minimum two questions from theory part of each module should be solved as a home work in A-3 size sketch book.
- B. A-3 size Printouts/plots of the problems solved in practical class from the practical part of each module

Problems from practical parts of each module should be solved using standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works, Inventor etc.

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

Home work sketch book	.....	20 marks
Printouts/Plots	.....	20 marks
Attendance (Theory and practicals)	.....	10 marks

Practical/Oral examination:

1. Practical examination duration is three hours, based on Part-B of the Term work, and should contain two sessions as follows:
 - Session-I:** Preparation of 3-D models of parts, assembling parts and preparing views of assembly from given 2-D detailed drawing.
 - Session-II:** Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing.

Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.
2. Questions provided for practical examination should contain minimum five and not more than ten parts.
3. The distribution of marks for practical examination shall be as follows:

Session-I	.....	20 marks
Session-II	.....	20 marks
Oral	.....	10 marks
4. Evaluation of practical examination to be done based on the printout of students work
5. Students work along with evaluation report to be preserved till the next examination

ReferenceBooks:

1. Machine Drawing by N.D. Bhatt.
2. A text book of Machine Drawing by Laxminarayan & M.L. Mathur. (Jain brothers Delhi).
3. Machine Drawing by Kamat & Rao.
4. Machine Drawing by M.B. Shah
5. A text book of Machine Drawing by R.B. Gupta (Satyaprakashan, Tech. Publication)
6. Machine Drawing by K.I. Narayana, P. Kanniah, K. Venkata Reddy.
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by Sham Tickoo, Surinder Raina (dreamtech Press).
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

Subject Code	Subject Name	Credits
AEL306	Database & Information Retrieval system[#]	02

Objective:

1. Learn and practice data modeling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply Graphical User Interface techniques for retrieve the information from database.
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Outcome: The student should be able to ...

1. To describe data models and schemas in DBMS.
2. To understand the features of database management systems and Relational database.
3. To use SQL- the standard language of relational databases.
4. To understand the functional dependencies and design of the database.
5. To understand the graphical user Interface design.

Module	Detailed content	Hours
1	Introduction Database Concepts: What is a database? , Characteristics of databases, Example of database, File system V/s Database system, What is DBMS?, Users of Database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data Independence, DBMS system architecture, Database Administrator,	02
2	Entity–Relationship Data Model : Introduction, Benefits of Data Modeling, Types of Models, Phases of Database Modeling, The Entity-Relationship (ER) Model, Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.	04
3	Relational Model and Algebra : Introduction , Mapping the ER and EER Model to the Relational Model , Data Manipulation , Data Integrity , Advantages of the Relational Model, Relational Algebra , Relational Algebra Queries, Relational Calculus.	04
4	Structured Query Language (SQL) : Overview of SQL , Data Definition Commands, Set operations , aggregate function , null values, , Data Manipulation commands, Data Control commands , Views-Using Virtual Tables in SQL, Nested and complex queries .	04
5	Introduction to Transactions Management and Concurrency: Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Concurrency Control: Lock-based , Timestamp-based , Validation-based protocols, Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Shadow paging.	04

6	<p>Graphical User Interface : Murphy 's Law of G U I Design, Features of G U I, Icons and graphics, Identifying visual cues, clear communication, color selection, GUI standard, planning GUI Design Work.</p> <p>Visual programming :</p> <p>Sharing Data and Code: Working with Projects, Introduction to Basic language, Using inbuilt controls and ActiveX controls, creating and using classes, Introduction to Collections, Using and creating ActiveX Components, dynamic data exchange, object linking and embedding</p> <p>Creating visual software entities: Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces.</p>	06
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* 2hours theory can be taught to entire class followed by 2hours practical in batches

Course common with Mech/Auto/Prod/Civil

Term Work:

Assign minimum two case studies for each student to perform on their case studies following experiments-

- 1) Problem Definition and draw ER /EER diagram
- 2) Design Relational Model
- 3) Perform DDL operation
- 4) Perform DML and DCL operations
- 5) Design Forms using Visual programming
- 6) Retrieve the information through GUI.

Distribution of marks for Term work shall be as follows:

Laboratory work (programs/printouts):	40 marks
Attendance (Theory and practicals):	10 marks

Practical/Oral Examination:

1. Practical examination duration is 2hours and questions to be based on the list of experiments mentioned in Term Work.
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Practical examination: 40 marks, oral examination based on practical examination: 10 marks
4. Students work along with evaluation report to be preserved till the next examination

ReferenceBooks:

1. G. K. Gupta :”Database Management Systems”, McGraw – Hill.
2. Korth, Sliberchatz,Sudarshan, :”Database System Concepts”, 6th Edition, McGraw – Hill
3. GUI Design for dummies,IDG books.
4. Visual Basic 2005, How to program (3RD Edition) Deitel&Deitel, Pearson Education.
5. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g,Black Book, Dreamtech Press
6. Mark L. Gillenson, PaulrajPonniah, “ Introduction to Database Management”,Weley
7. SharamanShah ,”Oracle for Professional”, SPD.
8. Raghu Ramkrishnan and Johannes Gehrke, “ Database Management Systems”,TMH
9. Mark L Gillenson, “Fundamentals of Database Management System”, Wiley India

Course Code	Course/Subject Name	Credits
AEL307	Machine Shop Practice – I^s	2

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 etc.
2. Perform plain turning, taper turning, screw cutting etc on lathe machine.
3. Perform machining operations on shaper.
4. Demonstrate metal joining process like compressive welding.

Module	Details	Hrs
1	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Taper Turning One job on Precision Turning, Taper Turning and Screw Cutting	18
2	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface	12
3	Introduction to various forging tools. Two jobs on Forging of Cutting Tools used on Lathe Machine	12
4	One simple exercise on Welding, Preparation of a component using Compressive Welding Joint	6

^s Courses common to Mech/Auto

Term Work:

1. All the jobs 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

Course Code	Course/Subject Name	Credits
AEC401	Applied Mathematics –IV[@]	4

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
1	<p>Matrices</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>	09
2	<p>Vector calculus</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>	11
3	<p>Non Linear Programming</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>	06
4	<p>Probability Distributions</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>	10
5	<p>Sampling Theory</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 difference between sample mean and population means, Test for</p>	10

	<p>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>	
6	<p>Correlation and Regression</p> <p>6.1 Correlation, Co-variance, Karl Pearson Coefficient of Correlation & Spearman's Rank Correlation Coefficient (non-repeated & repeated ranks)</p> <p>6.2 Regression Coefficients & lines of regression</p>	06

@ 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 VidyarthiGruhaPrakashan
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, Schaum Series
7. Operations Research, Kantiswarup, Manmohan, P K Gupta, S. Chand & CO.

Course Code	Course/Subject Name	Credits
AEC402	Fluid Mechanics^s	4+1

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
1	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	6
2	2 Fluid Kinematics: 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	6
3	3 Fluid Dynamics: 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)	12
4	4 Real fluid flows: 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, $1/7^{\text{th}}$ 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	8
5	5 Boundary Layer Flows: 5.1 Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer, laminar and turbulent boundary layers, laminar sub-layer; Von Karman	8

	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	6 Compressible Fluid flow: 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

^s 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
AEC403	Theory of Machines – I^s	4+1

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>1.1 Kinetics of rigid bodies 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>1.2 Basic Kinematics: 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>2.1 Special Mechanisms: Straight line generating Mechanisms: Exact Straight Line Generating Mechanisms – Peaucellier's and Hart's Approximate Straight Line Generating Mechanisms – Watt's, Grasshopper and Tchebicheff's. Offset slider crank mechanisms, Pantograph. Hook joint- single and double Steering gear mechanisms – Ackerman, Davis</p>	05
3	<p>3.1 Velocity Analysis of mechanisms (mechanisms up to 6 links). 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>3.2 Velocity and Acceleration analysis of mechanism. Velocity and Acceleration – analysis by relative method (mechanisms up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach).</p>	13

4	<p>4. Cam Mechanisms: 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.</p>	08
5	<p>5. Flexible Connectors: 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</p>	07
6	<p>6. Gears 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.</p>	07

^s 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.

ReferenceBooks:

1. Theory or Mechanisms and Machines By Amitabh Ghosh and A. Kumar Mallik.
2. Theory of Machines and Mechanism By John Uiker, 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
AEC404	Production Process – II[§]	4

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	Classification, Selection and application of Machine Tools: 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	CNC machines: 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	Metal Cutting & Tool Engineering: 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	Measurement of Tool Forces and Economics of metal cutting: 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	Surface Finish, Cutting Tool Materials, Coolants: 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	Design of Cutting Tools or Tool design: 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

[§] 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.

ReferenceBooks:

1. Tool Design by Donaldson.
2. Machining Process by H.L. Juneja
3. Production Technology - HMT
4. Manufacturing, Engineering and Technology SI by SeropeKalpakjian, 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 GeofferyBoothroyd
9. Manufacturing science by Ghosh and Mallick.

Course Code	Course/Subject Name	Credits
AEC405	Material Technology^s	3+1

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>Classification of Materials: Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples.</p> <p>Lattice Imperfections: 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>Deformation: 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>Strain Hardening: 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>Failure mechanisms:</p> <p>Fracture: Definition and types of fracture, Brittle fracture: Griffith's theory of fracture. Orowan's modification. Dislocation theory of fracture. 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>Fatigue Failure: 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>Creep: Definition and significance of creep. Effect of temperature and creep on mechanical behaviors of materials. Creep testing and data presentation & analysis. Mechanism and types of creep. Analysis of classical creep curve</p>	8

	and use of creep rate in designing of products for load bearing applications. Creep Resistant materials.	
3	Theory of Alloys & Alloys Diagrams : 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 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	8
4	Heat treatment Process: Technology of heat treatment. Classification of heat treatment process. 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. Surface hardening: Hardening and surface Hardening methods. Their significance and applications. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes	6
5	Effect of Alloying Elements in Steels: Limitation of plain carbon steels. Significance of alloying elements. Effects of major and minor constituents, Effect of alloying elements on ferrite, carbide, austenite, Effect of alloying elements on phase transformation Classification of tool steels and metallurgy of tool steels and special steels	4
6	Introduction to New materials: Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications. Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and nano composites. Polymers: Basic concepts, Processing methods, advantages and disadvantages over metallic materials, examples and applications.	4

^s 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/seminarreport):	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.

ReferenceBooks:

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 &HodderStoughlon, 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 - ReinhildPuplishing 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.BaileyMcMillan<d ,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, 3rd Ed., McGraw-Hill

Course Code	Course/Subject Name	Credits
AEC406	Industrial Electronics^s	3+1

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>Semiconductor Devices:</p> <p>Review of diodes: rectifier diode , zener diode, LED, photodiode 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>Phase controlledrectifiers and Bridge inverters:</p> <p>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>Operational amplifiers and 555 Timer:</p> <p>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, astablemultivibrator</p>	4
4	<p>Digital logic and logic families:</p> <p>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	<p>Microprocessor and Microcontrollers:</p>	8

	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)	
6	Motors: 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

^s 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 astablemultivibrator
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 ---VedamSubramanyam, 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, Narosapublications
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
AEL407	Machine Shop Practice – II[§]	2

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	48

[§] 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.