AC 29/4/2013 Item no. 4.69

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. Themajor 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 Learnerwith 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 Learnerin 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 to3 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 learnerare 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

AEC301	Applied Mathematics –III[@]	4

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	**Laplace Transform** 1.1 Function of bounded variation, Laplace Transform of standard functions such as 1, t^n, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$ 1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Heaviside Unit step function, Direc Delta function, Periodic functions and their Laplace Transform.	**6**
2	**Inverse Laplace Transform** 2.1 Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem. 2.2 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable.	**5**
3	**Complex variables:** 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. 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. 3.3 Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, invertion and reflection, translation.	**10**
4	**Complex Integral** 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. 4.2 Singularities and poles: 4.3 Taylor's and Laurent's series development (without proof) 4.4 Residue at isolated singularity and its evaluation. 4.5 Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta$, & $\int_{-\infty}^{\infty} f(x)\, dx$	**10**
5	**Fourier Series** 5.1 Orthogonal and orthonormal functions, Expressions of a function in a	**10**

	series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π & $2l$. 5.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series, Parsvel's identities (without proof) 5.3 Complex form of Fourier series.	
6	**Partial Differential Equations** 4.1 Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method(Crank- Nicolson method) Successive over relaxation method. 4.2 Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 4.3 Heat equation, steady-state configuration for heat flow. 4.4 Two and Three dimensional Laplace equations.	**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[$]**	**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	**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. **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.	**8**
2	**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. **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.	**8**
3	**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. **Property Relations:** Introduction to Maxwell relations, ClausiusClapeyron equation, volume expansivity and isothermal compressibility, Mayer relation, Joule-Thomson coefficient.	**8**
4	**Properties of Steam:** Dryness fraction, enthalpy, internal energy and entropy, steam table and Mollier chart, First law applied to steam processes. **Vapour Power Cycles:** Carnot vapour cycle, Rankine cycle, Ideal reheatRankine cycle, Introduction to cogeneration.	**8**
5	**Gas Power Cycles:** Air standard assumptions, Otto cycle, Diesel cycle, dual cycle, Stirling cycle, Ericsson cycle, Atkinson cycle, Brayton cycle.	**8**
6	**Reactive Systems:**	**8**

	Combustion, theoretical and actual combustion processes, enthalpy of formation and enthalpy of combustion, Adiabatic flame temperature, first law analysis of reactive system.	

[$] 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, 5^{TH} 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$**	**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 stressesinduced.
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	**Moment of Inertia:** Mass Moment of Inertia , Area Moment Of Inertia, Parallel Axis theorem, Polar Moment of Inertia, Principle axes, Principle moment of inertia **Stress and Strain:** Definition**,** Stress- strain,uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress-Elastic limit, Hooke's Law. **Elastic Constants:** Poission's Ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, Yield stress, Ultimate stress. 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, **Thermal Stress:**	12
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams includingbeams with internal hinges for different types of loading, relationship between rates of loading, shearforce & bending moment.	8
3	**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, Flitchedbeams **Direct & Bending Stresses**: Core of Section, Chimneys subjected to wind pressure **Shear Stress in Beams:** Distribution of shear stress, across plane sections used commonlyfor structural purposes, shear connectors.	8
4	**Torsion:** Torsion of circular shafts-solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel. **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.	8

5	**Deflection Of Beams:** Deflection of Cantilever, simply supported and over hanging beamsusing 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 hemi spherical 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

[$] 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.

ReferenceBooks:

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 Affliated East-West Press.
6. Mechanics of Materials, James M. Gere (5th Edition), Thomson Learning
7. Strength of Materials—S. Ramamrutham, DhanpatRai 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[$]**	**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**

[$] 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.

Module	**Details**	**Hrs.**	
		Theory	**Practical**
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 *any two*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 *(any two)*: 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*(any three):*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, 6.2 Jigs and Fixtures (*any two from each*) 6.3 Reverse Engineering of a physical model: disassembling of any physicalmodel 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	01 -- --	-- 06 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 Drawingby N.D. Bhatt.
2. A text book of Machine Drawing byLaxminarayan&M.L.Mathur.(Jain brothers Delhi).
3. Machine DrawingbyKamat&Rao.
4. Machine DrawingbyM.B.Shah
5. A text book of Machine Drawing by R.B.Gupta(Satyaprakashan, Tech. Publication)
6. Machine Drawing by K.I.Narayana, P.Kannaiah, K.Venkata Reddy.
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo,SurinderRaina (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	**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. **Visual programming :** ***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 ***Creating visual software entities:*** Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces.	06

* 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, Slberchatz,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[$]**	**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**

[$] 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	**Matrices** 1.1 Brief revision of vectors over a real field, inner product, norm, Linear Dependance and Independence and orthogonality of vectors. 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.	**09**
2	**Vector calculus** 2.1 Brief revision of Scalar and vector point functions, Gradient, Divergence and curl. 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)	**11**
3	**Non Linear Programming** 3.1 Unconstrained optimization, problems with equality constraints Lagranges Multiplier method. 3.2 Problem with inequality constraints Kuhn-Tucker conditions.	**06**
4	**Probability Distributions** 4.1 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.2 Probability Distributions:Binomial, Poisson and Normal Distributions. For detailed study.	**10**
5	**Sampling Theory** 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. 5.2 Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for	**10**

	significance of the difference between the means of two samples. 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. 5.4 Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method) 5.5 Chi-square distribution and its properties, Test of the Goodness of fit and Yate's correction.	
6	**Correlation and Regression** 6.1 Correlation,Co-variance, Karl Pearson Coefficient of Correlation & Spearman's Rank Correlation Coefficient (non-repeated & repeated ranks) 6.2 Regression Coefficients & lines of regression	**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 Mathematicals 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, Shaum Series
7. Operations Research, Kantiswarup, Manmohan, P K Gupta, S. Chand & CO.

Course Code	Course/Subject Name	Credits
AEC402	**Fluid Mechanics[$]**	**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, $1/7^{th}$ 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**

[$] 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 / orificementer / 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 reportto 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[$]**	**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. ConstructCAM profile for the specific follower motion.
5. Select appropriate power transmission mechanism.

Module	Details	Hrs
1	**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. **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), Kutzbachcrieterion, 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.	**08**
2	**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	**05**
3	**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 **3.2 Velocity and Acceleration analysis of mechanism.** Velocity and Acceleration – analysis by relative method (mechanismsup to 6 link) including pairs involving Coriolis acceleration (Graphical Approach).	**13**

4	**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.	**08**
5	**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	**07**
6	**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.	**07**

[$] 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. Merchants circle of cutting forces, expression for shear plane angle and coefficient of friction in terms of cutting forces and tool angles. Merchants 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$**	**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	**Classification of Materials:** Metallic materials, Polymeric Materials,Ceramics and Composites: Definition, general properties, applications with examples. **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. **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. **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	**8**
2	**Failure mechanisms:** **Fracture:** 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. **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. **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	**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**

[$] 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&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, 3rd Ed., McGraw-Hill

Course Code	Course/Subject Name	Credits
AEC406	**Industrial Electronics[$]**	**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	**Semiconductor Devices:** **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	6
2	**Phase controlledrectifiers and Bridge inverters:** 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)	8
3	**Operational amplifiers and 555 Timer:** 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	4
4	**Digital logic and logic families:** 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	5
5	**Microprocessor and Microcontrollers:**	8

	Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller, MSP430Functional 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

[$] 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 experimentduring practical examination
3. Students work along with evaluation reportto be preserved till the next examination

ReferenceBooks:

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 Digitals 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 operationssuch as precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.

AC 7/6/2014
Item No.- 4.19 &4.20

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Automobile Engineering

Third Year (Sem. V & VI) and Final Year (Sem. VII & VIII)

Revised Syllabus (REV- 2012) w.e.f. Academic Year 2014 - 15 and 2015-2016 respectively

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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 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 Mechanical Engineering. The Program Educational Objectives finalized for the undergraduate program in Mechanical 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 to3 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
T. E. Automobile-(Semester V)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC501	I C Engines[&]	4	2	4	1	5
AEC502	Metrology and Quality Engineering	4	2	4	1	5
AEC503	Production Process-III[&]	4	2	4	1	5
AEC504	Theory of Machines- II[&]	4	2	4	1	5
AEC505	Heat Transfer[&]	4	2	4	1	5
AEL5O1	Business Communication and Ethics[#]	-	2[$]+2	-	2	2
Total		**20**	**14**	**20**	**7**	**27**

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.					
AEC501	I C Engines[&]	20	20	20	80	03	25	25	150
AEC502	Metrology and Quality Engineering	20	20	20	80	03	25	25	150
AEC503	Production Process-III[&]	20	20	20	80	03	25	--	125
AEC504	Theory of Machines- II[&]	20	20	20	80	03	25	--	125
AEC505	Heat Transfer[&]	20	20	20	80	03	25	25*	150
AEL5O1	Business Communication and Ethics[#]	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

[$] Theory for entire class to be conducted **[#] Common with all engineering program**
[&] Common with Mechanical Engineering *** Only ORAL examination based on term work and syllabus**

T. E. Automobile-(Semester VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC601	Automotive System	3	2	3	1	4
AEC602	Machine Design I[&]	4	2	4	1	5
AEC603	Mechanical Vibrations[&]	4	2	4	1	5
AEC604	Thermal and Fluid Power Engineering[&]	4	2	4	1	5
AEC605	Operations Research	3	2	3	1	4
AEC606	Finite Element Analysis[&]	3	2	3	1	4
Total		**21**	**12**	**21**	**6**	**27**

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.					
AEC601	Automotive System	20	20	20	80	03	25	25	150
AEC602	Machine Design I[&]	20	20	20	80	03	25	--	125
AEC603	Mechanical Vibrations [&]	20	20	20	80	03	25	25*	150
AEC604	Thermal and Fluid Power Engineering[&]	20	20	20	80	03	25	--	125
AEC605	Operations Research	20	20	20	80	03	25	--	125
AEC606	Finite Element Analysis[&]	20	20	20	80	03	25	25	150
Total		**--**	**--**	**120**	**480**	**--**	**150**	**75**	**825**

[&] Common with Mechanical Engineering *** Only ORAL examination based on term work and syllabus**

B. E. Automobile-(Semester VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC701	Chassis Body Engineering	3	2	3	1	4
AEC702	CAD/CAM/CAE[&]	4	2	4	1	5
AEC703	Automotive Design	4	2	4	1	5
AEC704	Product Design and Development	4	2	4	1	5
AEE701X	Elective I	3	2	3	1	4
AEP701	Project I	--	6[#]	--	3	3
Total		**18**	**16**	**18**	**8**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./ oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
AEC701	Chassis Body Engineering	20	20	20	80	03	25	25	150
AEC702	CAD/CAM/CAE[&]	20	20	20	80	03	25	25	150
AEC703	Automotive Design	20	20	20	80	03	25	25*	150
AEC704	Product Design and Development	20	20	20	80	03	25	--	125
AEE701X	Elective I	20	20	20	80	03	25	--	125
AEP701	Project I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

[&] Common with Mechanical Engineering * Only ORAL examination based on term work and syllabus

B. E. Automobile-(Semester VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC801	Autotronics	4	2	4	1	5
AEC802	Vehicle Dynamics	4	2	4	1	5
AEC803	Vehicle Maintenance	4	2	4	1	5
AEE802X	Elective II	3	2	3	1	4
AEP802	Project II	--	12[#]	--	6	6
Total		**15**	**20**	**15**	**10**	**25**

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.					
AEC801	Autotronics	20	20	20	80	03	25	25	150
AEC802	Vehicle Dynamics	20	20	20	80	03	25	--	125
AEC803	Vehicle Maintenance	20	20	20	80	03	25	25	150
AEE802X	Elective II	20	20	20	80	03	25	--	125
AEP802	Project II	--	--	--	--	--	50	100	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**150**	**700**

* Only ORAL examination based on term work and syllabus

# indicates work load of Learner (Not faculty) in VII and VIII semester for Project

Project –I and II: Students groups and load of faculty per week

Project Groups : Students can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load: In semester VII – ½ an hour per week per project group

In semester VIII - 1 hour per week per project group

Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Course Code	Elective I	Course Code	Elective II
AEE7011	Power Plant Engineering &	AEE8021	Noise Vibrations & Harshness
AEE7012	Supply Chain Management &	AEE8022	Vehicle Safety
AEE7013	Tribology	AEE8023	World Class Manufacturing &
AEE7014	Computational Fluid Dynamics &	AEE8024	Knowledge Management
AEE7015	Automotive Embedded Systems	AEE8025	Project Management &
AEE7016	Industrial Robotics	AEE8026	Artificial Intelligence
AEE7017	Transportation Management Motor Industry	AEE8027	Virtual Reality

& Common with Mechanical Engineering

Course Code	Course/Subject Name	Credits
AEC501	**Internal Combustion Engines[&]**	**4+1**

[&]Common with Mechanical Engineering

Objectives

1. Study of air standard and actual engine cycles.
2. Study of SI and CI engine components and processes involved
3. Study and analysis of engine performance characteristics and engine emissions

Outcomes: Learner will be able to…

1. Differentiate SI and CI engines
2. Identify and explain working of engines components/systems
3. Plot and analyze engine performance characteristic
4. Perform exhaust gas analysis and comment on adverse implications on environment

Module	Detailed Contents	Hrs.
01	**Introduction** Heat engines; Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines and their comparative study; Scavenging and scavenging blowers, Air standard cycles and Fuel air cycles, Variable specific heat and its effects, Dissociation and other losses, Actual cycles, Deviation of actual engine cycle from ideal cycle	06
02	**Spark Ignition Engines** **A. Carburators and fuel injection system in S I Engines :** Theory of carburetion, Simple carburetor, Essential parts of modern carburetor, Types of carburators, Types of fuel injection systems in S I engines, Continuous injection system, Timed injection system, Electronic Fuel-Injection systems (EFIs), Advantages and disadvantages of SI engine fuel injection system **B. Ignition Systems :** Spark Plug and its requirements, Battery, Magneto, Electronic ignition systems **C. Combustion :** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Auto ignition, Detonation and Knocking, Factors affecting combustion and detonation, Types of combustion chambers	12
03	**Compression Ignition Engines** A. **Fuel Injection Systems :** Types i.e. Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit injector etc, Injection pumps, Fuel injector, Types of nozzle, Electronically controlled unit fuel injection system, C I Engine Governors: necessity and characteristics B. **Combustion :** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	12
04	**Engine lubrication :** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Effects on power output and engine efficiency, Methods, Types, Limits	08

05	**Engine Testing and Performance:** Measurement of BP, IP, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engines, Effect of load and Speed on mechanical, indicated thermal, break thermal and volumetric efficiencies, Heat balance sheet **Exhaust Emissions :** Exhaust gas analysis and methods, necessity, constituents, Air pollution due to engine exhaust, Pollution control devices and EURO, BHARAT standards **Fuels :** SI and CI engine fuels, Rating of fuels, Non conventional fuels: CNG, LPG, Bio-fuels, Hydrogen, Alcohol etc	06
06	**Alternative Potential Engines:** Stratified charge engine, Wankel engine, Free-piston engine, Stirling engine, VCR engine, Dual fuel engines, Multi fuel engines **Modern Trends in I C Engines**	04

List of Experiments

Part A: Study of physical systems in terms of constructional details and functions

1. 2 Stroke and 4 Stroke Engines
2. Carburetor.
3. Ignition system.
4. Fuel injection system.

Part B: Students shall perform at least 5 experiments from the list

1. Morse Test on petrol engine.
2. Speed Test on petrol or/and diesel engine.
3. Load Test on diesel engine (engines).
4. Heat Balance test on diesel or petrol engines.
5. Experimental determination of Air fuel ratio.
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines
7. Effect of Supercharging on Performance Characteristics of an engine

Term Work

Term work shall consist of minimum 6 experiments from the list out of which 4 must be actual trials on IC Engines and 1 case study/report (in group of not more than 3 students) on latest trends/developments in IC Engines

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

- Laboratory work (Experiments) **: 15 marks**
- Case Study/Report : **05 marks**
- Attendance (Theory and Practical) **: 05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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. Practical examination shall be conducted in a group of not more than 5 students. Examination shall be based on actual trials performed during the semester. Students are expected to actually take reading and plot the performance characteristics and comment.
2. Examiners are expected to evaluate results of each group and conduct oral based on the same
3. The distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance …… 15 marks
    ii. Oral …… ……. .10 marks
4. Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
2. Internal Combustion Engines, Shyam Agrawal, New Age International
3. Internal Combustion Engine, Mathur and Sharma
4. Internal Combustion Engines, Mohanty, Standard Book House
5. Internal Combustion Engine, Gills and Smith
6. Internal Combustion Engines Fundamentals, John B. Heywood
7. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
8. Internal Combustion Engine, V Ganesan - *TataMcGraw Hill*
9. Internal Combustion Engines, Richard Stone - *Palgrave Publication*
10. Internal Combustion Engine, S.L. Beohar
11. Internal Combustion Engine, P.M Heldt.
12. Internal Combustion Engines, V.L. Maleeve
13. Internal Combustion Engine, E.F. Oberi.
14. Internal Combustion Engine, Domkundwar

Course Code	Course/Subject Name	Credits
AEC502	**Metrology and Quality Engineering**	**4+1**

Objectives

1. Study the fundamentals of modem quality concepts and apply statistical techniques.
2. Study fundamentals of inspection methods and systems.
3. Study the principles and operation of precision measurement tools and equipment's used in modern manufacturing.

Outcomes: Learner will be able to…

1. Apply inspection gauge and checking systems.
2. Understand the purpose of critical dimensions in manufacturing.
3. Analyse simple parts for dimensional accuracy and functionality.

Module	Details	Hrs.
01	1.1 Introduction to Metrology, Fundamental principles and definitions, measurement standards / primary and tertiary standards, distinction between precision and accuracy. 1.2 Limits, fits and tolerances, Tolerance grades, Types of fits, IS919, GO and NO GO gauges- Taylor's principle, design of GO and NO GO gauges, filler gauges, plug gauges and snap gauges.	**05**
02	2.1 Comparators: Constructional features and operation of mechanical, optical, electrical/electronics and pneumatic comparators, advantages, limitations and field of applications. 2.2 Principles of interference, concept of flatness, flatness testing, optical flats, optical interferometer and laser interferometer. 2.3 Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols.	**12**
03	3.1 Screw Thread measurement: Two wire and three wire methods, floating carriage micrometer. 3.2 Gear measurement: Gear tooth comparator, Master gears, measurement using rollers and Parkinson's Tester. 3.3 Special measuring Equipments: Principles of measurement using Tool Maker's microscope, profile projector & 3D coordinate measuring machine.	**12**
04	**Quality Control:** Introduction, definition and concept of quality & quality control, set up policy and objectives of quality control, quality of design and quality of conformance, compromise between quality & cost, quality cost and planning for quality.	**07**
05	**SQC and SQC tools:** Importance statistical methods in QC, measurement of statistical control variables and attributes, pie charts, bar charts/ histograms, scatter diagrams, pareto chart, GANT charts, control charts, X chart, X bar charts, R charts, P charts, np charts their preparation, analysis and applications. Elementary treatment on modern SQC tools.	**08**
06	**Sampling Techniques:** Sampling inspection and basic concepts, OC curves, consumer & producer risk, single & double sampling plans and use of sampling tables.	**04**

List of Experiments

1. Use of comparators.
2. Thread measurement.
3. Gear measurement.
4. Use of Profile projectors.
5. Use of linear and angular measuring instruments.
6. Measurement of surface roughness.
7. Measurement of flatness.

Term Work

Term work shall consist of minimum 5 experiments from the list and presented with inferences and one assignment on each module

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Practical Engineering Metrology, K.W.B.Sharp, Pitman Publication
2. Engineering Metrology, K.J.Hume, Kalyani publication
3. Engineering. Metrology, I.C. GUPTA, DhanpatRai Publications.
4. Statistical quality control, A.L. Grant, McGraw Hill International, New York.
5. Engineering. Metrology, R.K.Jain, Khanna Publisher.
6. Metrology,Taher.
7. Statistical Quality control, R.C. Gupta
8. I.S. 919/1963.
9. I.S. 2709/1964.
10. Engineering. Metrology, Hume K.G., M C Donald, Technical &Scientific ,London.
11. Quality Control and Industrial Statistics, – Duncon A.J., D.B. Taraporevela& Co. Bombay.
12. Statistical quality Control, Mahajan M., DhanpatRai& Sons, Delhi.
13. Engineering Metrlogy-2nd Ed., P. Narayana, Scitech Publication.
14. Metal working & Metrology, P. Narayana et.al ,Scitech Publication.
15. Quality control 7 ed.,D.H. Besterfield Pearson education.
16. Juran's Quality Control Handbook.

Course Code	Course/Subject Name	Credits
AEC503	**Production Process - III[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives:

1. To study sheet metal forming as well as mechanical behavior of stress system in metal forming processes.
2. To develop capability to design jigs and fixtures.
3. To give exposure to Non-traditional machining operations.
4. To study concepts regarding modern manufacturing techniques like rapid prototyping, rapid tooling, agile manufacturing technologies etc.

Outcome: Learner will be able to…..

1. Understand sheet metal forming and various stress systems involved in metal forming operations.
2. Understand the intricacies involved in designing jigs and fixtures.
3. Get knowledge about non-conventional machining operations and its application areas.
4. Understand advanced concepts such as rapid prototyping and Agile manufacturing techniques.

Module	Details	Hrs.
01	Introduction to High speed machines, special purpose machines, transfer line and other mass production machines. Types of automats and its tooling.	**04**
02	**Sheet Metal Forming** Elementary treatment of press working, Operation on presses, Press devices Classification of presses, Constructional features of blanking, piercing, compound, combination, progressive, bending, forming and drawing dies, Load calculations, development of blanks, scrap strip layout, punches, selection of die sets, stock guides, strippers, pilots, stops etc. selection of presses, capacities and other details.	**10**
03	**Design of Jigs and Fixtures** Need for jigs and fixtures, elements of Jigs and fixtures, principles of location, design of locating elements, locating pins support pins spring back, vee blocks, etc. principles of clamping simple hand operated clamps, like screw clamp, lever clamps and other types of clamps. Drill bushes-their types and applications indexing devices, auxiliary elements. Design of drill jigs like plate, leaf solid and box types for drilling combined with reaming, spot facing etc. design of milling fixtures such as plain, string, gang and indexing types. Design of turning fixtures.	**12**
04	**Non-traditional Machining** Ultrasonic Machining (USM), Abrasive Jet Machining (AJM),Water Jet Machining, Electrochemical Machining (ECM),Chemical Machining (CHM)Electrical Discharge Machining (EDM),Plasma Arc Machining (PAM),Laser Beam Machining (LBM),Electron Beam Machining (EBM), Arc cutting processes and Oxy fuel cutting process.	**08**
05	**Plastics Injection Mold Design** General arrangement of an injection mold, Basic systems of the mold – Feeding system, cooling system and ejection systems, Concepts of three plate molds and tooling for moulding articles with undercuts, Concepts of split molds, hot runner systems – Their advantages and limitation over conventional systems. Basic concepts of mold standardization and innovative mold components.	**08**

06	**Agile Manufacturing Technologies** Introduction, Developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and knowledge and Computer control of Agile manufacturing. Flexible manufacturing systems.	**06**

Term Work

1. At least six assignments on concepts, Case studies and analysis based on the topics mentioned above.
2. Term work shall consist of minimum 6 assignments. The distribution of marks for term work shall be as follows

- Lab work (Case Studies): **10 marks**
- Assignments: **10 marks**
- Attendance: **05marks**

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Mechanical Metallurgy, G E Dieter ,McGraw Hill.
2. Jigs and Fixtures, P H Joshi, Mc Graw Hill.
3. Production Technology, R C Patel & C G Gupte.
4. Production Technology, HMT, Tata Mc Graw Hill.
5. Introduction to Jigs and Tool design, HA Kempster, Butterworth Heinemann Ltd.
6. Manufacturing Process, R A Lindberg, PHI India.
7. Agile Manufacturing- Forging Mew Frontiers, Poul T Kidd,Amagow Co. UK.
8. Agile Manufacturing, AGunasekharan, the 21st Century Competitive strategy, Elsevier Press,India.
9. Stereo Lithography and other RP & M Technologies, Paul F.Jacobs: SME, NY 1996.
10. Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London2001.
11. Fundamentals of modern Manufacturing, Fourth Edition, Mikell P Groover, John Wiley & Sons.
12. Metals handbook ,Forming and Forging, Vol. 14, ASM.

Course Code	Course/Subject Name	Credits
AEC504	**Theory of Machines-II[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. To acquaint with working principles of clutches and its constructional details.
2. To study working and types of brakes and dynamometers.
3. To acquaint with working principles and applications of gyroscope and governors.
4. To demonstrate different types of gear trains and its applications.

Outcomes: Learner will be able to…

1. Apply the working principles of clutches and its constructional details.
2. Analyze working of brakes and dynamometers.
3. Demonstrate working mechanism of different types of governors.
4. Analyze and select gear trains.
5. Analyze gyroscopic effect on various applications

Module	Details	Hrs.
01	**1.1 Clutches:** Requirements of Clutches, Types of Clutches and Clutch materials, Positive clutches, friction clutches, Friction Clutches - Analysis of frictional torque, power transmission .Power loss in Friction in single plate, multiple plate clutch, and cone clutch, Centrifugal Clutches - construction, working	**08**
02	**2.1 Brakes:** Requirement of brake, Types of Brakes, Analysis of Block brakes - external and internal, Band brake-simple and differential, Band and block brake - simple and differential, Braking of vehicles - front wheels, rear wheels, all wheels on level and inclined roads, **2.2 Dynamometers** - Absorption and transmission dynamometers, Study and analysis of absorption type dynamometer - Proney brake, Rope brake, dynamometers, Study and analysis of transmission type dynamometers - Belt transmission, epicyclical, torsion dynamometers, Froude hydraulic dynamometer	**08**
03	**3.1 Governors:** Comparison between governors and flywheel, Types - centrifugal governors, inertia governors, **3.2 Force analysis of gravity loaded governors** - Watt, Porter, Proell, Force analysis of spring loaded governors - Hartnell, hartung, Wilson Hartnell, Force analysis of spring and gravity loaded governor, Performance characteristics of governors- stability, sensibility, isochronisms, Hunting, governor effort and governor power, coefficient of insensitiveness.	**08**
04	**4.1 Gyroscope:** Introduction - Gyroscopic couple and its effect on spinning bodies, Gyroscopic effect on naval ships during steering, pitching and rolling., Ship stabilization with gyroscopic effect **Two wheeler and four wheeler on curved path** - effect of gyroscopic and centrifugal couples, maximum permissible speeds on curve paths, Gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft	**08**
05	**5.1 Gear Trains:** Kinematics and dynamic analysis of - simple gear trains, compound gear trains, reverted gear trains, epi-cyclic gear trains with spur or bevel gear combination. 5.2 **Transmissions:** Necessity of gear box, Sliding mesh, Constant mesh, Synchromesh and epicyclic gear box,	**08**

06	**6.1 Static and Dynamic force analysis** in slider crank mechanism (neglecting mass of connecting rod and crank), Engine force analysis, Turning moment on crank shaft. **6.2 Dynamically equivalent systems** to convert rigid body to two mass with and without correction couple. **6.3 Flywheel and its applications**, Fluctuation in energy, function of flywheel , estimating inertia of flywheel for reciprocating prime movers and machines.	**08**

List of Experiments

1. Study of Clutches
2. Study of Brakes
3. Experiments on Dynamometers - Rope Brake Dynamometer, Torsion Dynamometer
4. Experiments on Governors - Proell Governor, Hartnell Governor,
5. Experiments on Gyroscope
6. Study of power transmission system in automobile
7. Study of Cams & Followers.
8. Plotting of displacement-time, velocity-time, acceleration-time & jerk-time for uniform velocity, UARM, SHM &Cycloidal motion.
9. At least two numerical simulations using C++/MATLAB based on systems discussed in syllabus

Term Work

Term work shall consist of minimum **eight** experiments, assignments consisting numerical based on above syllabus, at least 3 numerical from each module.

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

- Laboratory work (Experiments) **: 10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **: 05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Theory of Machines - Thomas Bevan - C. B. S. Publishers
2. Theory of Machines - S. S. Ratan - Tata McGraw Hill
3. Theory of Machines - P. L. Ballaney, Khanna Publishers, Delhi
4. Dynamics of Machines – Norton, *McGraw Hill Publication*
5. Theory of Mechanisms and Machines - A. Ghosh and A. Malik - *Affiliated East – West Press Pvt. Ltd., New Delhi*
6. Theory of Machines - W. G. Green – *Bluckie & Sons Ltd.*
7. Mechanics & Dynamics of Machinery - J. Srinivas, *Scitech*
8. Kinematics, Dynamics and Design of Machinery, 2nd ed., Kenneth Waldron, Gary Kinzel, *Wiley India Edition*
9. Essential MATLAB for Engineers and Scientist - Brian D. Hanhn, Daniel Valentine,

Course Code	Course/Subject Name	Credits
AEC505	**Heat Transfer [&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. Study and analysis of basic heat transfer concepts applicable for steady state and transient conditions
2. Study mathematical modeling and designing concepts of heat exchangers

Outcomes: Learner will be able to…

1. Identify & explain the three modes of heat transfer (conduction, convection and radiation).
2. Develop mathematical model for each mode of heat transfer
3. Demonstrate and explain mechanism of boiling and condensation
4. Design and analyze different heat exchangers

Module	Detailed Contents	Hrs.
01	**Introduction** Typical heat transfer situations, Modes of heat transfer, heat transfer parameters, various thermo physical properties	02
02	**Conduction** Fourier's law of heat conduction, thermal conductivity, differential equation of heat conduction with heat generation in unsteady state in the Cartesian coordinate system, Boundary and initial conditions, Solution to three dimensional steady heat conduction problems, Steady heat conduction in plane walls, composite walls, Concept of thermal resistance and thermal resistance network, Heat conduction in cylinders and spheres, Differential equation of heat conduction in cylindrical co-ordinates, Conduction through Cylindrical and Spherical composite walls (Derivation NOT INCLUDED for Spherical walls), Critical thickness/radius of insulation and its importance.	10
03	**Extended Surfaces** Heat transfer from finned surfaces, Types of fins, Fin equation for rectangular fin and its solution, Fin efficiency, Fin effectiveness **Transient Heat Conduction** Lumped system analysis, One dimensional transient problems analytical solutions, One dimensional Heisler charts **Numerical Methods in Conduction** Importance of numerical methods, Finite difference formulation of one dimensional steady heat conduction equations	08
04	**Convection** Physical mechanism of convection, Natural and Forced convection, Velocity/hydrodynamic and Thermal boundary layer, Velocity and temperature profile, Differential equation of heat convection, Laminar flow heat transfer in circular pipe, constant heat flux and constant wall temperature, thermal entrance region, Turbulent flow heat transfer in circular pipes, Pipes of other cross sections, Heat transfer in laminar and turbulent flow over a flat plate, Heat pipe introduction and applications, Principles of dimensional analysis and its application in convective heat transfer, Empirical correlations for convection, Physical significance of various dimensionless numbers useful in natural and forced convection	10

05	**Radiation** Thermal radiation, Blackbody radiation, Radiation intensity, Radiative properties, Basic laws of radiation (Plank's law, Kirchoff's law, Stefan-Boltzman law, Wien's displacement law, Lambert's cosine law, Radiation exchange between black surfaces, Shape factor, Radiation exchange between gray surfaces, Radiosity- Irradiation method, Radiation shield and the radiation effect	08
06	**Boiling and Condensation** Boiling heat transfer, Pool boiling, Flow boiling, Condensation heat transfer, Film condensation, Dropwise condensation **Heat Exchangers** Types of heat exchangers, Overall heat transfer coefficient, Analysis of heat exchangers, LMTD method, Effectiveness-NTU method, Correction factor and effectiveness of heat exchangers	10

List of Experiments

1. Thermal conductivity of metal bar /composite wall / liquid /Insulating Material
2. Determination of contact resistance
3. Effect of area on Heat transfer
4. Radial heat conduction
5. Determination of fin efficiency and fin effectiveness
6. Unsteady state heat transfer
7. Heat pipe
8. Natural and Forced convection for flow over flat plate /through a circular pipe
9. Comparison of Overall heat transfer coefficient and effectiveness for double pipe/plate type /shell & tube heat exchanger
10. Determination of emissivity of a grey surface

Term Work

Term work shall consist of minimum 7 experiments from the list, 3 assignments containing numerical based on modes of heat transfer and One Assignment based on live problem relevant to heat exchanger analysis

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

- Laboratory work (Experiments) **:** **10 marks**
- Numerical Assignments : **05 marks**
- Live problem assignment**:** **05 Marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Oral examination

1. Oral examination shall be conducted based on term work and syllabus content
2. Examiners are expected to give small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Introduction to Thermodynamics and Heat Transfer, 2nd ed., Yunus A Cengel, McGraw Hill International.
2. Fundamentals of Heat and Mass Transfer, F. P. Incropera and D. P.DeWitt, Wiley India
3. Heat and Mass Transfer, 2nd ed., R Rudramoorthy and L Mayilsamy, PEARSON
4. Fundamentals of Engineering Heat and Mass Transfer, 4th ed., R C Sachdeva, New Age International
5. Heat Transfer, 2nd ed., A F Mills and V Ganesan, PEARSON
6. Heat Transfer, 9th ed., J P Holman, McGraw Hill
7. Engineering Heat and Mass Transfer, Mahesh M Rathore, Laxmi Publication
8. Principles of Heat Transfer, 6th ed., Frank Kreith, CENGAGE Learning
9. Heat and Mass transfer, 6th ed.,D S Kumar, S K Kataria and Sons
10. Heat Transfer, S P Sukhatme, University Press
11. Heat and Mass Transfer, 2nd ed., P K Nag, Tata McGraw Hill
12. Fundamentals of Heat and Mass Transfer, Thirumaleshwar, Pearson Education
13. Engineering Heat Transfer, N V Suryanarayana, Penram Publication
14. Heat and Mass transfer, C P Arora, Dhanpatrai and Co.
15. Heat Transfer, Y V C Rao, University Press
16. Heat and Mass Transfer, R K Rajput, S.Chand and Company
17. Elements of Heat Transfer, Jakole and Hawkins
18. Heat Transfer, James Sueee, JAICO Publishing House
19. Heat Transfer, Donald Pitts & L E Sisson, Schaums Series, Mc Graw Hill International
20. Engineering Heat Transfer, Shao Ti Hsu
21. Heat Transfer, M Necati Ozisik, McGraw Hill International edition
22. Heat Transfer, Ghosdastidar, Oxford University Press

Course Code	Course/Subject Name	Credits
AEL501	**Business Communication & Ethics[&]**	**2**

[#] Common with all Engineering Programs

Pre-requisite

- FEC206 Communication Skills

Objectives

1. To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach and an ability to understand engineer's social responsibilities.
2. To provide students with an academic environment where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career.
3. To inculcate professional ethics and codes of professional practice
4. To prepare students for successful careers that meets the global Industrial and Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Outcomes: A learner will be able to …..

1. communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities
2. Participate and succeed in Campus placements and competitive examinations like GATE, CET.
3. Possess entrepreneurial approach and ability for life-long learning.
4. Have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

Module	Unit No.	Topics	Hrs
1.0	**1.0**	**Report Writing**	**07**
	1.1	Objectives of report writing	
	1.2	Language and Style in a report	
	1.3	Types of reports	
	1.4	Formats of reports: Memo, letter, project and survey based	
2.0	**2.0**	**Technical Proposals**	**02**
	2.1	Objective of technical proposals	
	2.2	Parts of proposal	
3.0	**3.0**	**Introduction to Interpersonal Skills**	**07**
	3.1	Emotional Intelligence	
	3.2	Leadership	
	3.3	Team Buliding	
	3.4	Assertiveness	
	3.5	Conflict Resolution	
	3.6	Negotiation Skills	
	3.7	Motivation	
	3.8	Time Management	
4.0	**4.0**	**Meetings and Documentation**	**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice	
	4.3	Agenda	
	4.4	Minutes of the meeting	

5.0	**5.0**	**Introduction to Corporate Ethics and etiquettes**	**02**
	5.1	Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills	
	5.2	Greetings and Art of Conversation	
	5.3	Dressing and Grooming	
	5.4	Dinning etiquette	
	5.5	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.0	**6.0**	**Employment Skills**	**05**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	
		Total	**25**

List of Assignments

1. Report Writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal)
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (Case study, Role play)
7. Cover Letter and Resume
8. Printout of the PowerPoint presentation

Term Work

Term work shall consist of all assignments from the list.

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

- Assignments **:** **20 marks**
- Project Report Presentation**:** **15 marks**
- Group Discussion**:** **10 marks**
- Attendance **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of work assigned and minimum passing in the term work.

References

1. Fred Luthans, "*Organisational Behavior"* , Mc Graw Hill, edition
2. Lesiker and Petit, "*Report Writing for Business"* , Mc Graw Hill, edition
3. Huckin and Olsen,"*Technical Writing and Professional Communication"*,McGraw Hill
4. Wallace and Masters, "*Personal Development for Life and Work"* , Thomson Learning, 12th edition
5. Heta Murphy, "*Effective Business Communication"* , Mc Graw Hill, edition
6. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing",*
7. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill.Lehman,
8. Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
9. Bell . Smith, "Management Communication" Wiley India Edition,3rd edition.
10. Dr. K. Alex ,"Soft Skills", S Chand and Company
11. Dr.KAlex,"SoftSkills",S Chand and Company
12. R.Subramaniam,"Professional Ethics" Oxford University Press 2013.

Course Code	Course/Subject	Credits
AEC601	**Automotive Systems**	**3+1**

Objectives

1. To study basic and advance automotive systems.
2. To study working of different automotive systems and subsystems.
3. To study different vehicle layouts.
4. To have basic idea about how automotive systems are developed.

Outcomes: Learner will be able to……

1. Practically identify different automotive systems and subsystems.
2. Practically identify different automotive components.
3. Illustrate working and functions of various automotive components

Module	Details	Hrs.
1	**1. CLUTCHES** 1.1 Function requirements 1.2 Types of single plate clutch 1.3 Clutch control systems 1.4 Clutch center plate construction 1.5 Direct release clutch 1.6 Centrifugally operated clutches 1.7 Multiplate clutches 1.8 Angle spring clutch 1.9 Wet clutch	05
2	**2. TRANSMISSION** 2.1 Purpose and element of gear box 2.2 Constant mesh gear box 2.3 Sliding mesh gear box 2.4 Synchromesh gear box 2.5 Gear selector mechanism 2.6 Heavy vehicle gear boxes 2.7 Fluid coupling and torque convertors 2.7.1 Fluid coupling 2.7.2 Torque converters 2.8 Epicyclic gear box operation 2.9 Semi – Automatic and Automatic transmission 2.9.1 Hydraulic control systems 2.9.2 Electro hydraulic control systems 2.9.3 Automatic layshaft gear boxes 2.9.4 Dual mode transmission with sequential gear change 2.9.5 Direct shift gear boxes 2.9.6 Over drive gears 2.9.7 Continuously variable transmissions 2.10 Electric drives 2.10.1 General arrangement and description of electric transmissions 2.10.2 Working principle and control 2.10.3 Advantages and limitations of electric drives	08

3	**3. DRIVE LINES** 3.1 Drive Lines 3.1.1 Universal joints 3.1.2 Constant velocity joints 3.1.3 Propeller shaft construction 3.1.4 Drive line arrangement 3.1.5 Rear-wheel drive and front-wheel drive layouts 3.1.6 Front-wheel drive shafts 3.1.7 Tandem axle drive for heavy vehicles 3.1.8 Drive lines for public service vehicles	05
4	**4. FINAL DRIVE AND REAR AXLES** 4.1 Final drive gears and bearings 4.2 Differential gears 4.3 Differential- All types 4.4 Rear axle construction 4.5 Heavy vehicle rear axle 4.6 Four wheel drive systems 4.6.1 Basic consideration of four wheel drive 4.6.2 Part time four wheel drive 4.6.3 Full time four wheel drive	05
5	**5. BRAKING AND SUSPENSION SYSTEMS** 5.1 Braking System 5.1.1 Hydraulic brake systems 5.1.2 Air brake systems 5.1.3 Endurance brake systems 5.2 Suspension System 5.2.1 Basic ride considerations 5.2.2 Types of suspension systems 5.2.3 Types of suspension spring 5.2.4 Tandem axle suspension 5.2.5 Shock dampers 5.2.6 Adaptive suspension systems 5.2.7 Active roll control systems	07
6	**6. STEERING , TYRES, ROAD WHEELS AND HUBS** 6.1 Steering systems 6.1.1 Steering principles and layout 6.1.2 Front end geometry and wheel alignment 6.1.3 Steering and suspension ball joints 6.1.4 Manual steering gears 6.1.5 Steering axles for heavy vehicles 6.1.6 Hydraulic power-assisted steering 6.1.7 Speed-sensitive hydraulic power-assisted steering 6.1.8 Electro-hydraulic power-assisted steering 6.1.9 Electrical power-assisted steering 6.1.10 Types of four-wheel steering 6.2 Tyres, Road wheels and Hubs 6.2.1 Introduction to Tyre characteristics 6.2.2 Tyre construction 6.2.3 Road wheels and hubs	06

List of Assignments/Practical's

Study of cut section models covering all the modules is desirable.

1. Dismantling and reassembling of Clutch.
2. Dismantling and reassembling of Gear box.
3. Dismantling and reassembling of Propeller Shaft.
4. Dismantling and reassembling of Differential.
5. Dismantling and reassembling of Steering gear linkages and steering gear box.
6. Dismantling and reassembling of all types of braking systems.

Case Studies

Assign case studies for each student on any one of the following topics:

1. **Four wheelers**: Light and Heavy vehicles (Passenger and Commercial)
2. **Three wheelers**: Case study of Indian models. Front mounted engine and rear mounted engine types. Auto rickshaws, Pick up van, Delivery van and Trailer, Bijili electric vehicle.
3. **Two wheelers**: Case study of major Indian models of major motor cycles, scooters and mopeds.
4. **Off Road Vehicles:** Case study regarding working principle and construction of each- Earth Moving Machines, Scrappers, Graders, Shovels and Ditchers, Farm Equipment's, Military and Combat Vehicles.

Term Work

Term work shall consist of

A. Assignments/ Practical's as per list
B. Case Studies as above

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

- Part A **:** **10 marks**
- Part B : **10 marks**
- Attendance (Theory and Practical) **: 05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical/Oral examination

1. Practical examination shall be conducted in a group of not more than 4 students. Examination shall be based on dismantling and reassembling performed during the semester.
2. Examiners are expected to evaluate each group and conduct oral based on the same
3. The distribution of marks for practical/oral examination shall be as follows:
    iii. Practical performance …… 15 marks
    iv. Oral …… ……. .10 marks
4. Students work along with dismantling and reassembling evaluation report to be preserved till the next examination

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Light and Heavy Vehicle Technology, M.J. Nunney, Elsevier, Fourth Edition.
2. Automotive Technology, Jack Erjavec, Cengage Learning, Fifth Edition.
3. Automotive Braking, Thomas W. Birch, Cengage Learning, Third Edition.
4. Motor Automotive technology, Anthony E. Schwaller, Delmar, Third Edition.
5. Automotive suspension and steering systems, Thomas W. Birch, Delmar Cengage Learning, Third Edition.

Course Code	Course/Subject Name	Credits
AEC602	**Machine Design-I[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. To study basic principles of machine design
2. To acquaint with the concepts of strength design related to various components.

Outcomes: Learner will be able to…

1. Demonstrate understanding of various design considerations
2. Apply basic principles of machine design
3. Design machine elements on the basis of strength concept

Modules	Details	Hrs.
01	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design Material properties and their uses in design Manufacturing consideration in design Design considerations of casting and forging Basic principles of Machine Design, Modes of failures, Factor of safety, Design stresses, Principal stresses and strains, Theories of failures Standards, I. S. codes, Preferred Series and Numbers.	**06**
02	Curved Beams: Assumptions made in the analysis of curved beams. Design of curved beams: Bending stresses in curved beams, such as crane hook, C-frame, etc. Thick cylinders: Design of thick cylinders subjected to an internal pressure using Lame's equation.	**06**
03	Design against static Loads: Cotter joint, knuckle joint, Turn Buckle Bolted and welded joints under eccentric loading. Power Screw - Screw Presses, C- Clamps along with the Frame, Screw Jack	**12**
04	Design against Fluctuating Loads Variables stresses, reversed, repeated, fluctuating stresses Fatigue Failure Static and fatigue stress concentration factors Endurance limit - estimation of endurance limit Design for finite and infinite life Soderberg and Goodman design criteria Fatigue design under combined stresses	**06**
05	Design of shaft - power transmitting, power distribution shafts Module (excluding crank shaft) under static and fatigue criteria. Keys - Types of Keys and their selection based on shafting condition. Couplings- Classification of coupling. Design of Split muff couplings, Flange couplings, Bush pin flexible couplings	**11**
06	Design of Springs: Helical compression, tension springs under static and variable loads, Leaf springs.	**07**

List of Assignments

Design exercises in the form of design calculations with sketches and or drawings on following machine system

1. Knuckle joint,
2. Turn Buckle
3. Screw Jack
4. Flexible flange couplings

Term Work

Term work shall consist of

A. Minimum 3 design exercises from the list which may include computer aided drawing on A3 size sheets
B. Stress analysis of any machine element mentioned in the syllabus using any application software and programming language

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

- Part A **:** **15 marks**
- Part B : **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

NOTE:

Use of standard design data books like PSG Data Book, Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.

References

1. Design of machine elements -- V. B. Bhandari. Tara Mc-Graw Hill Pub.
2. Design of machine elements -- Sharma,Purohit. Prentice Hall India Pub.
3. Machine Design - An Integrated Approach -- Robert L. Norton – Pearson Education.
4. Machine Design - Pandya & Shah- Charotar PI/blishing.
5. Mechanical Engineering Design - J. E. Shigley - McGraw Hill
6. Recommended Data Books - PSG, K. Mahadevan
7. Machine Design - Reshetov - Mir Publication
8. Machine Design - Black Adams-Mcgraw Hill
9. Fundamentals of Machine Elements - Hawrock, Jacobson Mcgraw Hill
10. Machine Design - Patel, Pandya, Sikh, Vol. - I & II, C. Jamnadas & Co. Educational & Law Publishers
11. Design of Machine Elements - V.M. Faires
12. Design of Machine Elements - Spotts.

Course Code	Course/Subject Name	Credits
AEC603	**Mechanical Vibration[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. To study basic concepts of vibration analysis
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

Outcomes: Learner will be able to…

1. Develop mathematical model to represent dynamic system
2. Estimate natural frequency of mechanical element/system
3. Analyze vibratory response of mechanical element/system
4. Estimate the parameters of vibration isolation system

Modules	Details	Hrs
01	**1.1 Basic Concepts of Vibration :** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. **1.2 Free Undamped Single Degree of Freedom Vibration System** Longitudinal, transverse, torsinal vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's Method,.	**08**
02	**2.1 Free Damped Single Degree of Freedom Vibration System** : Viscous damped system – under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping; Combined viscous and coulomb's damping. **2.2 Equivalent Single Degree of Freedom Vibration System :** Conversion of multi-springs, multi masses, multi – dampers into a single spring and damper with linear or rotational co-ordinate system	**08**
03	**3.1 Free Undamped Multi Degree of Freedom Vibration System :** Eigen values and Eigen vectors for linear system and torsional two degree of freedom; Holzer method for linear and torsional unbranched system; Two rotors, Three rotors and geared system; Dunkerley's and Rayleigh's method for transverse vibratory system	**09**
04	**4.1 Forced Single Degree of Freedom Vibratory System :** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) **4.2 Vibration Isolation and Transmissibility:** Force Transmissibility, Motion Transmissibility Typical isolators& Mounts **4.3 Rotor Dynamics:** Critical speed of single rotor, undamped and damped.	**09**
05	**5.1 Vibration Measuring Instruments:** Principle of seismic instruments, vibrometer, accelerometer - undamped, damped **5.2** Introduction to Conditioning Monitoring and Fault Diagnosis.: Atleast two case studies in detail based on Conditioning Monitoring and Fault Diagnosis.	**06**
06	**6.1 Balancing** Static and dynamic balancing of multi rotor system, Balancing of reciprocating masses In-line engines, V- engines (excluding radial Engines)	**08**

List of Experiments

1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system.
2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel
3. Experimental prediction of natural frequencies, and nodal points for single rotor and two-rotor vibratory system, and comparison with theoretical results
4. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory)
5. Experimental investigation of viscous and coulomb damping, prediction of system parameter (spring stiffness, damping coefficient) from damped oscillations
6. Experimental and theoretical investigation of frequency response of mechanical system, and comparing both and justification of discrepancy between theory and experiments
7. Experiments' on distributed parameter system: Transverse vibrations of beam (Dunkerley's Rule Expt.)
8. Experimental balancing of single and multi-rotor system.
9. Introduction to FFT analyzer, and prediction spectral response of vibrating machine from workshop.
10. Experiments on vibration isolation system and prediction of force transmissibility, motion transmissibility of system.
11. Vibration analysis of mechanical system using MATLAB

Term Work

Term work shall consist of minimum 8 experiments from the list and one assignment on each module containing at least 5 numerical.

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Oral examination

1. Oral examination shall be conducted based on term work and syllabus content
2. Examiners are expected to give small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Mechanical Vibrations 4th ed- S. S. Rao - *Pearson Education*
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibration - S.Graham Kelly - *Tata McGraw Hill* 4.
4. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
5. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- *McGraw Hill*
1. Mechanical Vibrations - Schaum's outline series - William W. Seto- *McGrmvHill* .
2. Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - *New Age International Publications.*
3. Mechanical Vibrations - Den; Chambil, Hinckle
4. Mechanical Vibrations, J.P. Den Hartog, McGrawhill Book Company Inc.
5. Leonard Meirovitch, Introduction to Dynamics and Conti'oJ. *Wiley, New York,*
6. Leonard Meirovitch, Elements of Vibration Analysis. *McGrmv-Hill, New York,*
7. Leonard Meirovitch, Dynamics and Control of Structures. *Wiley, New York.* 4. Antony J. Pettofrezzo, Matrices and Transformations. Dover, New York.
8. Benson H. Tongue, Principles of Vibration. *Oxford University Press.*
9. W. Thomson, Theory of Vibrations with Applications, Second Edition, *Pearson Education*
10. Vibrations-BalakumarBalachandan, Edward Magrab, *CENGAGAE Learning.*

Course Code	Course/Subject Name	Credits
AEC604	**Thermal and Fluid Power Engineering[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. To study boilers, boiler mountings and accessories
2. To study utilization of thermal and hydraulic energy
3. To study gas turbine and its applications

Outcomes: Learner will be able to…

1. Identify utilities of thermal and hydraulic energy
2. Differentiate impulse and reaction turbines
3. Analyze performance of turbines

Module	Detailed Contents	Hrs.
01	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories. Layout of a modern HP boiler. Equivalent evaporation of boilers. Boiler performance. Boiler efficiency	08
02	**Steam Nozzle and Turbines** Flow through steam nozzle-velocity at exit and condition for maximum discharge, nozzle efficiency **Steam Turbine-** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram. Condition for max efficiency. Reaction turbine - velocity diagram, degree of reaction, Parson's turbine. Condition for maximum efficiency	10
03	**Impact of Jets and Water Turbines** Impact of jet on flat and curved plates Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Pelton Turbine:** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines:** Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters.	10
04	Similarity relations in turbines, definition of unit quantities and specific quantities, selection of turbines. Prediction of results of prototypes from the model test. Cavitations in turbines - causes, effects and remedies, Thoma's cavitations parameter G. Use of G v/s specific speed graphs. Determination of safe height of installation for the turbine. Characteristics of turbines, governing of turbines.	06

05	**Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration. Effect of operating variable on thermal efficiency and work ratio,	08
06	**Jet Propulsion Engines** Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency, Afterburner, Introduction to Turbojet, Turbofan, Ram jet, Turboprop and Rocket engine	06

List of Experiments

1. Study/Demonstration of Boilers
2. Study/Demonstration of Boiler mountings and accessories
3. Study of Steam Turbine
4. Trial on Impulse turbine
5. Trial on reaction turbine
6. Study of gas turbines
7. Study of Jet propulsion engines
8. Visit to Thermal Power Plant/Hydroelectric Power Plant/Gas Turbine Power Plant

Term Work

Term work shall consist of minimum 6 experiments from the list, 3 assignments containing numerical based on maximum contents of the syllabus and a visit report

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **05 marks**
- Visit report**:** **05 Marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Practical Boiler Operation Engineering and Power Plant, A R Mallick, 3rd ed, PHI Learning
2. Thermal Engineering, Ballaney, Khanna Publishers, Reprint 1994
3. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, Dhanpatrai& Sons.
4. Turbines, Compressors & Fans, S M Yahya, TMH
5. Thermal Engineering, R K. Rajput, Laxmi Publication
6. Steam and gas turbine, R Yadav
7. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
8. Hydraulic Machinery, JagdishLal
9. Hydraulic Machines, Vasandani
10. Fluid Mechanics and Machinery-B C S Rao, McGraw Hill
11. Fluid Mechanics and hydraulic Machines,Gupta, Pearson Education
12. Principles of Thermodynamics, H.A. Sorensen, Amerimal Publications, 1972.
13. Applied Thermodynamics for Engineers and Technologists, Eastop and Mcconky Longman,1978
14. Hydraulic Turbines - Nechleba

Course Code	Course/Subject	Credits
AEC605	**Operations Research**	**3+1**

Objectives

1. To understand, different resources used in industries and optimize them.
2. To understand different quantitative methods of optimization.
3. To understand fundamentals of optimization technique that will help in higher study.
4. To have basic idea about quantitative techniques to be used in automobile industries.

Outcomes: Learner will be able to…..

1. Develop fundamental knowledge of optimization technique.
2. Formulate the industrial problem for optimization of resources.
3. Minimize idle time, manufacturing cost and maximize profit, sales etc.

Modules	Details	Hrs.
01	**Linear Programming** Problem Formulation, Graphical Method, Simplex Method – Artificial Variable Techniques - Big M- Method, Two Phase Method – Duality – Dual Simplex Method.	06
02	**Transportation Problem** Formulation – Solution by North West corner rule, Row Minima Method, Matrix Minima Method, Vogel's Approximation Method – Optimality by MODI Method – Unbalanced Transportation Method – Degeneracy. **Assignment** Formulation – Optimality by Hungarian Method, Travelling Salesman Problem.	06
03	**Queuing Models** Introduction, Poisson Arrivals – Exponential Service – Single Channel with Finite and Infinite Population. **Game Theory** Introduction, Maximin & Minimax Principle, Graphical Method (2 x m & n x 2) matrix – Method of Dominance – Method of Marices.	06
04	**Project Management** Phases of Project Management, Network construction, Critical Path Method, Project Evaluation & Review Technique – Resource Analysis-Resource Leveling.	06
05	**Inventory Control** Introduction – Deterministic Model – Instantaneous demand with & without shortage- Models with one and Multiple price break. **Simulation** Definition, Types of Simulation Models – Monte Carlo Technique – Practical Problems – Applications in Inventory & Queuing problems.	06
06	**Decision Theory** Introduction – Decision Making Environment – Decision Under Uncertainty, Criterion of Pessimism, Criterion of Optimism, Laplace Criterion, Hurwitz Criterion, Criterion of Regret – Decision Making Under Risk, Expected Monetary Value (EMV) Criterion, Expected Opportunity Loss (EOL) Criterion – Decision Tree.	06

Term Work

Term work shall consist of minimum 06 assignments, at least one from each module. Introduction of software is desirable.

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

- Assignments : **20 marks**
- Attendance (Theory and Practical) **: 05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. R. Pannerselvam, Operations Research: PHI Publications.
2. N.D. Vohra, Quantitative Technique in Management: Tata McGraw Hill Education Pvt. Ltd.
3. S.S. Rao, Optimization: Theory and Applications, New Age International Pvt. Ltd.
4. Introduction to Operations Research, Taha, Pearson Education

Course Code	Course/Subject Name	Credits
AEC606	**Finite Element Analysis[&]**	**3+1**

[&] Common with Mechanical Engineering

Objectives

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To study the applicability of FEM to a range of Engineering Problems.
3. To acquaint with applications of numerical techniques for solving problems.

Outcomes: Learner will be able to…

1. Solve ordinary and partial differential equations using the Galerkin method.
2. Develop the finite element equations to model engineering problems governed by 2nd order partial differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems.
4. Use commercial FEA software, to solve problems related to mechanical engineering.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM. 1.2 Mathematical Modeling of field problems in Engineering, Governing Equations, Differential Equations in different fields. 1.3 Approximate solution of differential equations-- Weighted residual techniques, Least squares, Galerkin methods, Boundary Value problems.	06
02	**FEA Procedure** 2.1 Discrete and continuous models, Weighted Residual Methods – Ritz Technique – Basic concepts of the Finite Element Method. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions. 2.3 Minimization of a functional. Principle of minimum total potential. Piecewise Rayleigh-Ritz method. Formulation of "stiffness matrix"; transformation and assembly concepts.	06
03	**One-Dimensional Problems** 3.1 One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors. 3.2 Assembly of Matrices - solution of problems in one dimensional structural analysis, heat transfer and fluid flow (Stepped and Taper Bars, Fluid Network, Spring-Cart systems) 3.3 Analysis of Plane Trusses, Analysis of Beams. 3.4 Solution of one Dimensional structural and thermal problems using FE Software, Selection of suitable Element Type, Modeling, Meshing, Boundary Condition, Convergence of solution, Result analysis, Case studies.	06
04	**Two Dimensional Finite Element Formulations** 4.1 Introduction, Three nodded triangular element, four nodded rectangular element, four nodded quadrilateral element, eight nodded quadrilateral element. 4.2 Natural coordinates and coordinates transformations: serendipity and Lagranges methods for deriving shape functions for triangular and quadrilateral element 4.3 Sub parametric, Isoperimetric, super parametric elements. Compatibility, Patch Test, Convergence criterion, Sources of errors.	06

05	**Two Dimensional Vector Variable Problems** 5.1 Equations of elasticity – Plane stress, plane strain and axisymmetric problems. 5.2 Jacobian matrix, stress analysis of CST and four node Quadratic element 5.3 Solution of 2-D Problems using FE Software (structural and Thermal), selection of element type, meshing and convergence of solution. (Can be covered during practical hours).	06
06	**Finite Element Formulation of Dynamics and Numerical Techniques** 6.1 Applications to free vibration problems of rod and beam. Lumped and consistent mass matrices. 6.2 Solutions Techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams. 6.3 Finding frequencies of beam using FE Software (Can be covered during practical hours).	06

List of Assignment

Students should use the commercial software or programmes from the text-books or self-developed programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs should be included in the Journal. The proposed list is as given below;

1 Any two problem using bar element
2 Any two problems using truss element
3 Any two problems using CST element
4 Any one problem using axisymmetric element
5 Any one problem of free vibration analysis using bar element
6 Any one problem on Steady State Heat conduction.

Course Project

A group of not more than four (04) students, shall do Finite Element Analysis of any mechanical engineering element/system, which involves element selection, assigning properties, meshing, assigning loads and boundary conditions, analysis and result interpretation.

Term Work

Term work shall consist of minimum **06** assignments and course project. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments): **10** Marks.
- Course project: **10** Marks.
- Attendance: (Theory and Practicals): **05** Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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. Practical examination duration is 2 hours.
2. Assignment for the examination shall be based on the list of assignment mentioned in the term work.
3. The distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance: 15 marks
    ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Seshu. P. "Textbook of Finite Element Analysis" Prentice Hall of India, 2003.
2. J.N. Reddy, "Finite Element Method" Tata McGraw Hill, 2003.
3. Chandrupatla and Belegundu, "Introduction to Finite Elements in Engineering" 4th Ed Pearson Education, 2012.
4. Logan. D.L. "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
5. Cook R.D., Malkus. D.S. Plesha, ME., "Concepts and Applications of Finite Element Analysis", John – Wiley Sons 2003.
6. S.S. Rao, "The Finite Element Method in Engineering "Butter worth Heinemann, 2001.
7. M. Asghar Bhatti, "Fundamental Finite Element Analysis and Applications with Mathematica and MATLAB Computations", Wiley India Pvt. Ltd.

Course Code	Course/Subject	Credits
AEC701	**Chassis and Body Engineering**	**3+1**

Objectives

1. Understand fundamentals of Vehicle Body design
2. Study different vehicle structural design and their requirements.
3. Study Vehicle Aerodynamics.
4. Design vehicle body structures

Outcomes: Learner will be able to……

1. Design and implement knowledge practically of Vehicle structures.
2. Develop efficient and safe designs with consideration of all constraints.

Module	Detailed Contents	Hrs.
01	**Fundamental aspects of Vehicle Bodies** **1.1** Chassis and structure types: Open, Semi integral and Integral bus structure. Frames: functions and types of frames, Loads on frames, Load distribution of structure. 1.2 Classification of motor vehicle, Location of power plant, Location of different chassis components, 1.3 Terminology and overview of structural surface types, history and Overview of structural types. Basic concept of design. 1.4 Vehicle body materials and their selection: Detail study of materials used in vehicle body building (Steel sheet, timber, plastics, FRP, GRP etc, properties of materials-Corrosion anticorrosion methods, scalation of paint and painting process)	8
02	**Vehicle body styles** **2.1 Car Body Details:** Types: Saloon, Convertibles, Limousine, Estate van, racing and sports car. Visibility: regulations, driver's visibility, test for visibility, Methods of improving visibility and space in cars. Safety: safety design, safety equipments for car. Car body construction, Front assembly, Roof Assembly, Under floor, bonnet etc. **2.2 Bus Body Details:** Types, mini bus, single Decker, double Decker, two levels, split level and articulated bus. Bus Body Lay Out: Floor height, engine location, entrance and exit location, seating dimensions. Constructional details: Frame construction, Double skin construction-Types of metal section used-Regulations-Conventional and Integral type construction. **2.3Commercial Vehicle Body Details:** Types of bodies, flat platform, drop side, fixed side, tipper body, tanker body, light construction vehicle body types, Dimensions of driver seat in relation to control, Driver cabin design.	8
03	**Vehicle Aerodynamics:** Objectives, Vehicle drag and types, various types of forces and moments, Effects of forces and moments, side wind effects on forces and moments, various body optimization techniques for minimum drag .Calculation of drag.	6

04	**Ergonomics and Preliminary Design** **3.1** Design and requirement of Driver, Passenger and child seat. 3.2 Drawing of the preliminary design-Vehicle Body Weight Analysis, Calculation of C.G for Vehicle, Vehicle Weight Distribution and Master Model. 3.3 Overall Criteria for Vehicle Comparison: Design, Running costs, Overall Design Efficiency.	6
05	**Body Loads** **5.1 Loads on Vehicles:** Bending, Torsion, Lateral and Braking and Acceleration Load Cases, Shear Panel Method **5.2** Calculation of loading cases Static loading case, Asymmetric loading case, Longitudinal loads, Side Loads, Calculation of different cases.	4
06	**Strength of Vehicle Body Elements** 6.1 Thin Walled Structures-General Principle, Torsion, Torsion centre, Forces in End Load Carrying Members. Effect of Holes, Spot welded joints. 6.2 Latest Trends in Design, Manufacturing and Materials.ULSAB Design, Tailored blanks. Manufacturing Process: Hydro forming tubular, Sheet Stamping	4

List of Experiments

1. Structural Analysis of Chassis Frame using CAD Software for different sections (C-section, I-section, L-section, O-section, Hat section, Tubular section etc)
2. Mini Project: Containing a 3D Model of Chassis or Body or combination of both (Min 2 Max 4 Students per Group)
3. Industrial Visit

Term Work

Term work shall consist of experiments from the list, 6 assignments based on complete syllabus, industrial visit report and a mini project report

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

- Laboratory work (Experiments) **:** **05 marks**
- Mini project : **05 marks**
- Assignment**:** **05 marks**
- Industrial visit report: **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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. Practical examination duration is 2 hours.
2. Practical examination shall be based structural analysis and mini project mentioned in the term work.
3. The distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance: 15 marks
    ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. John Fenton, "Vehicle Body Layout & Analysis", Hutchinson, London.
2. J Powloski, "Vehicle Body Engineering", Business Books Ltd., London.
3. J.G. Giles, "Body Construction and Design", Vol. 6. llefe Books/Butterworth & Co. London
4. P. L. Kohli, "Automotive Chassis & Body", Papyrus Publishing House, New Delhi.
5. John Fenton, "Handbook of Automotive Body Construction and Design Analysis" Professional Engineering Publishing.

Course Code	Course/Subject Name	Credits
AEC702	**CAD/CAM/CAE[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.

Outcome: A learner will be able to….

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects and store and manage data.
3. Prepare part programming applicable to CNC machines.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

Modules	Details	Hrs.
01	**Computer Graphics and Techniques for Geometric Modeling** Computer Graphics: Two dimensional computer graphics, vector generation, the windowing transformation, Three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Perspective projection, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing. The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, parametric representation of line, circle, ellipse & parabola. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	08
02	**Transformation, Manipulation & Data Storage** 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. Object transformation, mirror transformation, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering.	08
03	**NC & CNC Technology** Tape coding & format, Manual Part Programming, Computer Aided Part Programming, CNC functions & advantages, DNC, adaptive Control, CNC programming concepts, Trends & new developments in NC, Part programmers job, functions of a post processor, NC part programming languages, Elements of a APT language, The Macro Statement in APT, NC programming with interactive graphics. Constructional details of CNC machines, Feed back devices- Velocity & displacement, Machining Centers and its types, Automated Material Handling & storage Systems like Robots, AGVs and AS/RS etc.	08
04	**Computer Aided Engineering (CAE)** Fundamentals of computer aided engineering, CAE includes mass property calculations, kinematic analysis and animation (movement, visualization, simulation and FEA). Case study based on modeling and analysis of structural, thermal/fluid, and dynamic (vibration analysis) system. Parameter optimization.	08

05	**Computer Integrated Manufacturing & Technology Driven Practices** Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	08
06	**Rapid Prototyping and Tooling** Introduction to RP, Technology Description, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, Classes of RP systems: Stereo-lithography Approach (SLA), SLA with photo-polymerization (mathematical modelling of the process), SLA with liquid thermal polymerization, Selective Laser Sintering (SLS), Fused deposition modelling, Laminated object manufacturing, Laser powder forming. Prototype properties: Material properties, colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties. RP Applications: Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, RP processes for MEMS, Photolithography, Direct Laser Writer, Bulk Lithography for 3D micro fabrication (Modelling of beam propagation and curing in resin system).	08

List of Exercises

1. Programming for transformations,
2. Solid modeling using any 3D modeling software
3. Part programming and part fabrication on CNC trainer (Turning / Milling)
4. Geometrical optimization of any mechanical component using computer aided engineering concepts.
5. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.
6. Rapid tooling for any one of the engineering or medical applications.

Term Work

Term work shall consist of any three exercises from the above list and a course project in a group of not more than three (3) students on either computer aided engineering or rapid prototyping and tooling

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

- Exercises : **15** marks
- Course Project : **05** marks
- Attendance (Theory & Practical) : **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Practical / Oral Examination

Practical examination of 2 hours duration based on any one of the following.

1) Programming for Algorithms, transformations.
2) Part Programming and machining of components.
3) 3D Modeling on software.
4) Analysis of component for optimization

The distribution of marks for practical/oral examination shall be as follows:

i. Practical performance: 15 marks
ii. Oral: 10 marks

Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
9. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*
14. "Flexible Manufacturing Systems" by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*
15. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
16. "Mathematical Elements for Computer Graphics", Rogers D F I and Adams J A, McGraw-Hill.

17. “Computer Integrated Manufacturing Hand Book” by Eric Teicholz, Joel N. Orr, McGraw Hill International Editions
18. “Rapid Prototyping” Chee Kai ChuaWorld Scientific Publishing
19. “Rapid Prototyping:Principles and Applications” RafiqNoorani, Wiley
20. “Rapid Prototyping:Principles and Applications” C.K. Chua,K.F.Leong, C.S. Lim World Scientific Publishing
21. “Rapid Prototyping and Manufacturing” P. F. Jacobs, Society of Manufacturing Engineers.

Course Code	Course /Subject	Credits
AEC703	**Automotive Design**	**4+1**

Objective

1. Provide students with the fundamental knowledge in the field of automotive design.
2. Develop analytical abilities to give solutions to Automotive design problems

Outcome: Learner will be able to…

1. Design automotive component to meet desired needs
2. Apply the fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machine for actual design problems

Modules	Details	Hrs.
01	**Design of Principal parts of I.C. Engines** 1. Cylinder and cylinder liner- Material Selection, Design of cylinder 2. Piston, piston rings and piston pin or gudgeon pin- Material Selection, Design considerations, Design calculations 3. Connecting rod with small and big end bearing-forces acting on connecting rod, Design considerations, Design calculations	**12**
02	**Design of Principal parts of I.C. Engines** 1.Crank, crankshaft and crank pin 2. Cam shaft and Valve Operating mechanism.	**08**
03	**Design of Clutches and Gear Boxes:** single plate, multiple plates, centrifugal clutch, lining material, lever design, sliding mesh, constant mesh, synchromesh gear box, gear ratio and gear shifting lever, sliding mechanism	**08**
04	**Design of Drive train:** Design of propeller shaft and U-joints, Design of propeller shaft, criteria, failure theories-joint design, Design of Final drive and differential	**08**
05	**Brakes and Suspension:** internal expanding shoe brake, friction lining material, leaf spring, coil spring, materials, suspension system and linkages, independent suspension	**06**
06	**Advanced automotive Body Structures:** Emphasis is on body concept for design. Material selection and manufacturing constraints	**06**

Term Work

Term work shall consists of exercises on the above topics in the form of design calculations with sketches and/ or drawings, Complete design and preparation of drawings for at least four components using CAD Software and Analysis software, Class Assignments and course project where a group of 3 or 4 students shall perform Stress analysis of any machine element using any analysis software like ANSYS/MSC, NASTRAN etc. and submit report as term work

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

- Exercises/Assignment : 10 Marks
- Course Project : 10 Marks
- Attendance (Theory & Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Note

Use of standard design data books like PSG data book, Mahadevan book is permitted at the examination and shall be supplied by the college.

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.

Oral examination

1. Oral examination shall be conducted based on term work and syllabus content
2. Examiners are expected to give small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1) Machine Design – Khurmi Gupta. S.Chand pub..
2) Design of machine elements -- V. B. Bhandari. *Tara Mcgraw Hill Pub.*
3) Design of machine elements—Sharma, Purohit, Prentice Hall india publication
4) Machine Design by Pandya & shah, Charolar Publishing
5) Mechanical Engineering Design – J.E.Shiegly- McGraw hill
6) Recommended Design Data Books- PSG, Kalaikathir Achchagam Publishing
7) Recommended Design Data Books -Mahadevan,
8) Design of machine element – Spotts.
9) Design of machine element – V.M.Faires.
10) Machine Design – Black Adams- McGraw Hill
11) Machine Design – Rashetov- Mir Publication

Course Code	Course/Subject Name	Credits
AEC704	**Product Design & Development**	**4+1**

Objectives

1. To understand fundamental product design concepts
2. To understand product design methodologies
3. To understand product design needs and issues in industry

Outcomes: Learner will be able to……

1. To design the products as per the customer/industry requirements
2. To apply product design tools and techniques

Module	Detailed Contents	Hrs.
01	**1. INTRODUCTION** 1.1 Introduction to product design. 1.2 Classification/ Specifications of products. 1.3 Product life cycle & Product mix. 1.4 Modern product development process. 1.5 Innovative thinking. 1.6 Morphology of design (7 phases)	**08**
02	**2. CONCEPTUAL DESIGN** 2.1 Generation, selection & embodiment of concept. 2.2 Product architecture. 2.3 Significance of Industrial design process. 2.4 Introduction to Design Of Experiments (DOE) for Robust Design, Taguchi Designs.	**08**
03	**3. DESIGN FOR MANUFACTURING AND ASSEMBLY** 3.1 Methods of designing for manufacturing & assembly. 3.2 Designs for maintainability. 3.3 Designs for environment. 3.4 Product costing.	**10**
04	**4. DESIGN METHODOLOGIES** 4.1 Value engineering and Value analysis. 4.2 Failure Mode Effect Analysis (FMEA) 4.3 Concurrent engineering 4.4 Quality Function Deployment (QFD) 4.5 Reverse engineering	**10**
05	**5. DESIGN FACTORS** 5.1 Ergonomics and Aesthetics. 5.2 Anthropometry. 5.3 Man-Machine interaction. 5.4 Concepts of size and texture, color 5.5 Comfort criteria. 5.6 Psychological & Physiological considerations. 5.7 Economic factors.	**06**
06	**6. PRODUCT DESIGN NEEDS AND ISSUES IN INDUSTRY** 6.1 Customer needs: types, models and collection of customer needs information, analysis of information**,** Rapid prototyping, Tools for product design – Drafting / Modeling software, CAM interface. 6.2 Creativity Techniques: Creative thinking, conceptualization, Brain storming, primary design, drawing, simulation, detail design. 6.3 Legal and social issues. Engineering ethics and issues of society related to design of products, Patents & IP Acts. Overview, Disclosure preparation.	**06**

Term Work

Term work shall consists of minimum six assignments one from each module and Case studies on product design and development

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

- Exercises/Assignment : 10 Marks
- Case studies : 10 Marks
- Attendance (Theory & Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Karl T Ulrich, Steven D Eppinger, "Product Design & Development.", Tata McGraw-Hill New Delhi 2003.
2. David G Ullman, "The Mechanical Design Process." McGrawhill Inc.
3. N J M Roozenberg, J Ekels, N F M Roozenberg "Product Design Fundamentals and
4. Methods", John Willey & Sons 1995.
5. Hollins B & Pugh S "Successful Product Design." Butterworths London.
6. Baldwin E. N. & Neibel B. W. "Designing for Production.", Edwin Homewood Illinois
7. Jones J. C. "Design Methods." Seeds of Human Futures, John Willey New York.
8. Bralla J. G. "Handbook of Product Design for Manufacture, McGrawhill NewYork**.**
9. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice - Hall India.
10. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000.

Course Code	Course/Subject Name	Credits
AEE7011	**Power Plant Engineering&**	**3+1**

& Common with Mechanical Engineering

Objectives

1. Study basic working principles of different power plants
2. Study power plant economics

Outcomes: Learner will be able to…

1. Comprehend various equipments/systems utilized in power plants
2. Discuss types of reactors, waste disposal issues in nuclear power plants
3. Illustrate power plant economics

Module	Detailed Contents	Hrs.
01	Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.	04
02	Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.	06
03	Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.	08
04	Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermo dynamic efficiency of combined cycles. Problems.	06
05	Nuclear Power Plants: Principles of nuclear energy, basic nuclear rea ctions, nuclear reactors- PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.	06
06	Power Plant Economics: Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-out put curves, efficiency, heat rate, economic load sharing, Problems.	06

List of Experiments

1. Case study report on at least two types of power plants
2. Group presentation (Group shall not be more than 3 students) on topics relevant to syllabus
3. Industrial visit to any power plant

Term Work

Term work shall consist of one case study report and 5 assignments covering maximum syllabus

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

- Case study**:** **05 marks**
- Industrial visit report: **05 marks**
- Presentation: **05 marks**
- Assignments : **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Power Plant Engineering, A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, New Age International Publishers
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. Power Plant Engineering, 2nd ed, P.K. Nag , Tata McGraw-Hill Pub. Com., New Delhi.
4. Hydro-Electric and Pumped Storage Plants, M G Jog, New Age International Publishers
5. A Text Book of Power Plant Engineering, R.K. Rajput, Laxmi Publications
6. A Course in Power Plant Engineering, Arora, Domkundwar, DhanpatRai & Co.
7. Power Plant Engineering, P.C. Sharma, S.K. Kataria& Sons.
8. Power Plant Engineering, G.R. Nagpal, Khanna Publishers
9. Power station Engineering and Economy by Bernhardt G.A. Skrotzki and William A. Vopat, Tata Mc Graw Hill Publishing Campany Ltd., New Delhi
10. Nuclear Energy An Introduction to the Concepts, Systems and Applications of Nuclear Processes, 6th Edition, Raymond L Murray, , ELSEVIER
11. Power Plant Engineering, Manoj Kumar Gupta, PHI Learning
12. Nuclear Power Plant Engineering, James Rust, Haralson Publishing Company
13. Nuclear Power Plants, Edited by Soon Heung Chang, InTech Publishers, 2012
    Nuclear Power Plants, Geotge Petridis and DimitriosNicolau, NOVA Publishers

Course Code	Course/Subject Name	Credits
AEE7012	Supply Chain Management[&]	3+1

[&] Common with Mechanical Engineering

Objectives

1. To develop an understanding of key drivers of supply chain performance and their inter-relationships with strategy.
2. To impart analytical and problem solving skills necessary to develop solutions for a variety of supply chain management & design problems.
3. To understand the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.

Outcomes: Learner will be able to…..

1. Illustrate the role & functions of supply chain management and its processes.
2. Analyze the flows of material, information and funds in an integrated manner.
3. Evaluate various performance measures of supply chain management.

Module	Detailed Contents	Hrs.
01	**Building a Strategic Frame Work to Analyse Supply Chains** Supply chain stages and decision phases, Process view of supply chain: Supply chain flows, Examples of supply chains, Competitive and supply chain strategies, Achieving strategic fit: Expanding strategic scope, Drivers of supply chain performance. Framework for structuring drivers: inventory, transportation facilities, information obstacles to achieving fit.	04
02	**Designing the Supply Chain Network** Distribution Networking: Role, Design, Supply Chain Network(SCN):Role, Factors, Framework for design decisions.	05
03	**Materials Management** Scope, Importance, Classification of materials, Procurement, Purchasing policies, Vendor development and evaluation. Inventory control systems of stock replenishment, Cost elements, EOQ and its derivative modules.	06
04	**Dimensions of Logistics** Introduction: A Macro and Micro Dimensions, Logistics interfaces with other areas, Approach to analyzing logistics system, Logistics and systems analyzing: Techniques of logistics system analysis, factors affecting the cost and Importance of logistics.	06
05	**Warehouse and Transport Management** Concept of strategic storage, Warehouse functionality, Warehouse operating principles, Developing warehouse resources, Material handling and packaging in warehouses, Transportation Management, Transport functionality and principles, Transport infrastructure, transport economics and Pricing. Transport decision making.	07
06	**IT in Supply Chain** 6.1 IT framework, Customer Relationship Management(CRM),internal Supply chain management, Supplier Relationship Management (SRM) and Transaction Management.Coordination in a Supply Chain 6.2 Lack of supply chain coordination and the Bullwhip effect, Obstacle to Coordination, Managerial levers, Building partnerships and trust. Emerging Trends and Issues 6.3 Vendor managed inventory-3PL-4PL, Reverse logistics: Reasons, Role, Activities; RFID systems: Components, Applications, Implementation; Lean supply chain, Implementation of Six Sigma in supply chain, Green supply chain.	08

Term Work

Term work shall consist of,

1. Assignments: On topics drawn from syllabus [At least 1 assignment per module].
2. Seminar / case study on the modules / trending scenario (current) in industry.

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

Seminar / Case study Presentation & report	**10** marks
Assignments:	**10** marks
Attendance (Theory and Practical):	**05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Supply Chain Management Strategy, Planning, and operations*, Sunil Chopra and Peter Meindl
2. *Materials Management & Purchasing*, Ammer D.S. Taraporawala
3. *Designing & Managing Supply chain*, David Simchi Levi, Philip Kaminsky& Edith Smichi Levi
4. *Supply Chain Redesign: Transforming Supply Chains into Integrated Value Systems*, Robert B Handfield, Ernest L Nicholas
5. *The Management of Business Logistics: A Supply Chain Perspective*, Coyle, Bardi, Langley

Course Code	Course/Subject Name	Credits
AEE 7013	**Tribology**	**3+1**

Objectives

1. To provide students with the fundamental knowledge in the field of Industrial tribology.
2. To provide basic concepts in the design of automotive lubrication system.
3. To provide knowledge of friction and wear mechanism in automotive system.

Outcome: Lerner will be able to….

1. apply knowledge of tribology for industrial component design
2. apply design concepts practically for automotive lubrication systems

Module	Detailed Contents	Hrs.
1	**Introduction to Tribology** Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, lubrication, basic modes of lubrication, lubricants, properties of lubricants-physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion. Types of sliding contact bearings, comparison of sliding and rolling contact bearings	**06**
2	**Friction and Wear** Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.	**06**
3	**Hydrodynamic lubrication** Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold„s equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, center of pressure, friction in tilting pad thrust bearing.	**06**
4	**Hydrostatic Lubrication** Hydrostatic lubrication: Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions. Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane.	**06**
5	**Elasto-hydrodynamic Lubrication and Gas Lubrication** Elastohydrodynamic Lubrication: Principle and application, pressure-viscosity term in Reynolds equation, Hertz theory. Ertel- Grubin Equation Gas lubrication: Introduction, merits and demerits, applications. Lubrication in metal working: Rolling, forging, drawing and extrusion. Bearing materials, bearing constructions, oil seals, shields and gaskets	**06**
6	**Surface Engineering** Introduction to surface engineering, concept and scope of surface engineering, manufacturing of surface layers, solid surface geometrical, mechanical and physic chemical concepts, superficial -layer, development of concept, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer.	**06**

Term Work

Term work shall consist of at least one (1) assignment from each module and a case study or seminar by each student.

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

- Assignments: 10 marks
- Seminar / Case study Presentation & report: 10 marks
- Attendance (Theory and Practical): 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Cameron A., "Basic Lubrication Theory", Wiley Eastern Ltd.
2. Shizhu Wen, "Principles of Tribology", Wiley
3. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi
4. Fuller D. D., "Theory and Practice of Lubrication for Engineers", John Wiley and Sons
5. Halling J., "Principles of Tribology", McMillan Press Ltd.
6.
7. B. Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill
8. Davis J., "Surface Engineering for corrosion and Wear Resistance", Woodhead Publishing, 2001
9. Tadausz Burakowski, "Surface Engineering of Metals: Principles, Equipments, Technologies", Taylor and Francis

Course Code	Course/Subject Name	Credits
AEE 7014	**Computational Fluid Dynamics[&]**	**3+1**

[&] Common with Mechanical Engineering

Objectives

1. Study basic principles of modeling a system using software
2. Study grid generation and discretization methods

Outcomes: Learner will be able to…

1. Demonstrate & explain geometrical model of a fluid flow
2. Describe specific boundary conditions and solution parameters

Module	Detailed Contents	Hrs.
01	**Introduction:** What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Softwares, Solution methodology-Preprocessing, Solver, Post processing.	04
02	**Mathematical description of Physical Phenomenon:** Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems	06
03	**Grid Generation and Discretization Methods:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discritization Concept, The Structure of the Discritization Equation. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	**Heat Conduction, Convection and Diffusion:** Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection	06
05	**Incompressible Fluid Flow:** Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	06
06	**Finite Volume Methods**: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusionproblems, FVM solutions to convection-diffusion problems - one and twodimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	06

List of Experiments

1. Simulate and solve, two problems, each 2-d and 3-d steady and unsteady flows using any commercial CFD package like Ansys-FLUENT, STAR CCM, FLUIDYNE, Ansys-CFX, etc.
2. Write codes for, at least one each, 1-d and 2-d steady conduction with and without source and do the post processing to verify with analytical results
3. Write codes, at least one, for steady, 2-d conduction-advection problems and do the post processing to verify with analytical results

Term Work

Term work shall consist of experiments from the list, 3 assignments covering maximum portion of the syllabus.

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

- Laboratory work (Experiments) **:** **15 marks**
- Assignments : **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984.
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India.
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi1995.
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd., 1998.
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.1981.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag, 1987.
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House, 1997.

Course Code	Course/Subject Name	Credits
AEE 7015	**Automotive Embedded Systems**	**3+1**

Objectives

1. To provide broad introduction to automotive embedded systems
2. To provide a comprehensive overview about existing and future automotive electronic systems.
3. To enable undergraduates to be able to design and apply embedded systems.

Outcomes: Learner will be able to…

1. Ability to design automotive component to meet desired needs.
2. Competence to apply the fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machine for actual design problems.
3. Develop analytical abilities to give solutions to automotive design problems.

Module	Detailed Contents	Hrs.
01	**Introduction** Body and convenience electronics, Vehicle power supply controllers and lighting modules, Door control modules Safety electronics: Active safety systems such as ABS, ASR& ESP etc., Passive safety systems such as restrained systems and their associated sensor in an automobile. Power train electronics :Petrol Engine Management, Infotainment electronics: Dashboard /Instrument cluster, car audio, telematics system, navigation system, multimedia systems etc. Cross application technologies:42 volt vehicle power supply system	06
02	**Embedded Communications** A Review of Embedded Automotive Protocols, Dependable Automotive CAN Networks, Flex Ray Protocol	08
03	**Drive By Wire** Challenges and opportunities of X by Wire: System and design requirements steer by wire, brake by wire, suspension by wire, gas by wire, power by wire, and shift by wire. Future of automotive Electronics	06
04	**Hardware Modules** MC9S12XD family features Modes of operation: functional block diagram overview, Programming model Map Overview Pulse width Modulator(PWM) On chip ADC serial communication protocol: SCI,SPI,IIC,CAN	06
05	**Software Developments Tools** Introduction to HCS12XDT512 Student learning kit & PBMCU(Project board), Introduction to code warrior IDE: editing, debugging simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing	06
06	**Integration of Software and Hardware** Downloading the software from Host Machine to target Machine, Implementing Application Prototype: Power windows and automotive lighting system	04

Term Work

Term work shall consist of 6 assignments (One on each module) covering maximum portion of the syllabus.

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

- Assignments : **20 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Automotive Electronics By Tom H.Denton
2. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman / Pearson Education
3. Automtive Embeded System Handbook by Nicolas Navet/CRC PRESS
4. Distributed Automotive Embeded System
5. Embeded System Handbook by Richard Zurawski

Course Code	Course/Subject Name	Credits
AEE 7016	**Industrial Robotics**	**3+1**

Objectives

1. To understand basic needs and requirements of robotics in industry.
2. To learn basic kinematics required in designing of robots.
3. To write and embed programs in robots.

Outcomes: Learner will be able to…

1. Appreciate the significance of robot in industry.
2. Design and make the robot for particular industrial problem.

Module	Detailed Contents	Hrs.
01	**Fundamentals of Robotics** Introduction, Fundamentals of Robot Technology, Programming, and Applications **Robot Technology: The Robot and its Peripherals** Control Systems and Components, Robot Motion Analysis and Control, Robot End Effectors, Sensors in Robotics, Machine Vision	08
02	**Kinematics of robotics.** Types of joints and motion, Basic of kinematics in robotics, Inverse kinematics, Balancing of **robots**	06
03	**Robot Programming and Languages** Robot Programming on microcontrollers., Robot Languages, Artificial Intelligence	04
04	**Robot Applications in Manufacturing** Application of robot in processing, assembly and inspection. ASRS(Automatic storage and retrieval system), AGV(Automated guided Vehicles)	06
05	**Implementation Principles and Issues** Technical issues involved in implementing Robotics, its Safety, Training, Maintenance and Quality	06
06	**Social Issues and the Future of Robotics** Social and Labor Issues, Robotics Technology of the Future	06

Term Work

Term work shall consist of 6 assignments (one on each module) covering maximum portion of the syllabus.

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

- Assignments : **20 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Robert Shilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India
2. J.J, Craig, Introduction to Robotics, Pearson Education
3. Fu, Gonzales and Lee, Robotics, McGraw Hill
4. Curtis D. Johnson, Process Control Instrumentation Technology, PHI Publication, Eighth Edition
5. Staughard, Robotics and AI, Prentice Hall of India
6. Grover, Wiess, Nagel, Oderey, Industrial Roboticsî, McGraw Hill
7. Walfram Stdder, Robotics and Mechatronics,
8. Niku, Introduction to Robotics, Pearson Education
9. Klafter, Chmielewski, Negin, Robot Engineering, Prentice Hall of India
10. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications
11. George L Balten Jr., Programmable Controllers , Tata McGraw Hill publication
12. Handbook of Industrial Robotics: Ed. Shimon Y. Nof, John Wiley. ISBN: 9780471177838.

Course Code	Course/Subject Name	Credits
AEE 7017	**Transportation Management & Motor Industries**	**3+1**

Objectives

1. To study basic concepts of transport management
2. To study different types of motor insurance

Outcomes: Learner will be able to…

1. To improve existing transport management systems
2. To implement advance techniques in traffic management

Module	Detailed Contents	Hrs.
01	**1. Motor Vehicle Act** 1.1 Short titles & definitions 1.2 Laws governing to use of motor vehicle & vehicle transport 1.3 Licensing of drivers & conductors 1.4 Registration of vehicle 1.5 State & interstate permits 1.6 Traffic rules, Signals & controls 1.7 Accidents, Causes & analysis 1.8 Liabilities & preventive measures 1.9 Rules & regulations 1.10 Responsibility of driver 1.11 Public & public authorities 1.12 Offences, penalties & procedures 1.13 Different types of forms 1.14 Government administration structure 1.15 Personnel, Authorities & duties 1.16 Rules regarding construction of motor vehicles	04
02	**2. Taxation** 2.1 Objectives 2.2 Structure & methods of laving taxation 2.3 One time tax 2.4 Tax exemption & tax renewal	08
03	**3. Insurance** 3.1 Insurance types & significance 3.1.1 Comprehensive 3.1.2 Third party insurance 3.2 Furnishing of particulars of vehicles involved in accident 3.3 MACT (Motor Accident Claims Tribunal) 3.4 Solatium Fund 3.5 Hit & Run case 3.6 Duty of driver in case of accident 3.7 Surveyor & Loss Assessor, Surveyor.s report	04
04	**4. Passenger Transport Operation** 4.1 Structure of passenger transport organizations 4.2 Typical depot layouts 4.3 Requirements and Problems on fleet management 4.4 Fleet maintenance 4.5 Planning - Scheduling operation & control 4.6 Personal & training-training for drivers & conductors 4.7 Public relations, Propaganda, publicity and passenger amenities 4.8 Parcel traffic.	08

	4.9 Theory of fares-Basic principles of fare charging 4.10 Differential rates for different types of services 4.11 Depreciation & debt charges 4.12 Operation cost and Revenues 4.13 Economics & records	
05	**5. Goods Transport Operation** 5.1 Structure of goods transport organizations 5.2 Scheduling of goods transport 5.3 Management Information System (MIS) in passenger / goods transport operation 5.4 Storage & transportation of petroleum products	06
06	**6. Advance Techniques in Traffic Management** 6.1 Traffic navigation 6.2 Global positioning system	06

List of Experiments

1. Organization & Management of Motor Vehicle Department
2. Collection & study of different types of RTO forms.
3. Central Motor Vehicle rules
4. Taxation, Insurance & Permits
5. Study of accidents claims & survey report including post accident procedure
6. Study of depot layouts (passenger & goods transport)
7. Case study of MIS in passenger / goods transports organization
8. Collection & study of goods transport records.
9. Study of vehicle navigation system
10. Advanced traffic control devices

Term Work

Term work shall consist of 8 experiments from the list, 6 assignments (One on each module) covering maximum portion of the syllabus.

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Motor Vehicle Act - Governmment of India Publications
2. Economics of Transport, S.K. Shrivastava
3. Transport Development in India, S. Chand & Co. Pvt. Ltd., New Delhi.

Course Code	Course/Subject Name	Credits
AEC 801	**Autotronics**	**4+1**

Objectives

1. To study basic and advance Automotive Electronics systems.
2. To study working of different Automotive Electronics systems and subsystems.
3. To study basic and advance electronics technologies like Battery, Fuel Cell, ECM etc.
4. To have basic idea about how automotive electrical systems are developed.

Course Outcomes: Learner will be able to……

1. Practically identify different automotive Electronics systems and subsystems.
2. Practically identify and demonstrate Systems like Battery, Alternator, Dynamo, Starter Motors, and Sensors etc.

Module	Detailed Contents	Hrs.
01	**1. Battery** 1.1 Requirement, 1.2 Construction, 1.3 Principle of operation, 1.4 Working of Lead acid, alkaline, Zebra, Sodium Sulphur, Swing, batteries, 1.5 Ratings, 1.6 Charging. 1.7 Maintenance & testing of Lead acid battery. **2. Fuel Cells** 2.1 Introduction of Fuel Cells & fuel used 2.2 Constructions and Operation of proton Exchange membrane 2.3 Alkaline Fuel Cell. 2.4 Medium & high temperature fuel cells, 2.5 Reformers. **3. 42-volt technology** 3.1 Introduction, 3.2 Transition from 12V to 42V electrical system, 3.3 Need of 42V automotive electrical system. 3.4 42V automotive power system, 3.5 Method of controlling 12V system in 42V architecture, 3.6 Present developments in 42 volt technology.	08
02	**1. Charging System** 1.1 Requirements of charging system 1.2 Dynamo 1.2.1 Principle of operation 1.2.2 Construction 1.2.3 Working 1.2.4 Regulators, Combined current & voltage regulator etc. 1.3 Alternator 1.3.1 Principle of operation 1.3.2 Construction 1.3.3 Working 1.3.4 Rectification from AC to DC **2. Starting system** 2.1 Requirements of starting system	08

	2.2 Various torque terms used 2.3 Starter motors drives 2.3.1 Bendix 2.3.2 Folo through Barrel 2.3.3 Rubber compression 2.3.4 Compression spring 2.3.5 Friction clutch 2.3.6 Overrunning clutch 2.3.7 Dyer 2.4 Starter motor solenoids & switches 2.5 Glow plugs **3. Integrated Starter and Alternator**	
03	**1. Electronic Ignition System** 1.1 Capacitor Discharge Ignition system 1.2 Distributer less Ignition System 1.3 Direct Ignition System, 1.4 Hall Effect pulse generator 1.5 Inductive pulse generator 1.6 Constant dwell system 1.7 Constant energy system **2. Electronic Engine controls** 2.1 Electronic control module (ECM) 2.2 Operating modes of ECM (closed loop & open loop) 2.3 Inputs required & output signals from ECM 2.4 Electronic spark timing 2.5 Electronic spark control 2.6 Air management system 2.7 idle speed control	08
04	**1. Sensors & Actuators** 1.1 Automotive Sensors, 1.1.1 Thermisters, 1.1.2 Inductive Sensors, 1.1.3 Position Sensors (Rotary, Linear) 1.1.4 Pressure Sensors, 1.1.5 Knock Sensor, 1.1.6 Optical Sensor 1.1.7 Hot wire & thin film air flow sensor, 1.1.8 Turbine fluid flow sensors 1.1.9 Light sensor, 1.1.10 Methanol sensor 1.1.11 Rain sensor operating principles 1.1.12 Oxygen sensor 1.1.13 Application & new developments in sensor technology 1.2 Automotive Actuators 1.2.1 Introduction, 1.2.2 Function & operating principle 1.2.3 Construction & working of solenoid actuators, 1.2.4 Relays 1.2.5 Motorized actuators, 1.2.6 Thermal Actuators 1.2.7 Electro hydraulic & Electrochemical Valve actuators, 1.2.8 Application & new developments in the actuators technology. 1.2.9 Stepper motors.	08

05	**1. Automotive Lighting and wiring harness systems.** 1.1 Lighting 1.1.1 Energy demand of lighting system 1.1.2 Types of Lamps i. Head lamp: Construction & types. Setting & control ii. Fog Lamp iii. Side Lamp iv. Tail lamp v. Parking lamp vi. Brake warning light vii. Trafficators viii. Blinkers ix. Flashers x. Electronic flasher circuit xi. Instrument panel lights xii. Body interior illumination xiii. Adaptive lighting system. 1.1.3 Reflectors: Parabolic, Bifocal, Homifocal, poly-ellipsoidal 1.1.4 Gauges: Fuel, Temperature, Oil pressure etc. 1.1.5 Accessories: Electric horn, wipers, Fuel pump, Power operated windows. 1.2 Wiring 1.2.1 Cables 1.2.2 Sizes 1.2.3 Colors & color codes 1.2.4 Connectors 1.2.3 Multiplex wiring system	08
06	**Introduction to Automotive embedded system and Intelligent vehicle system. Telematics, X by wire, GPS etc.**	08

List of Experiments

1. Study of Lead Acid Battery.
2. Study of Fuel Cells.
3. Dismantling, Inspection & assembly of A. C. Generator/Dynamo.
4. Dismantling, Inspection & assembly of Starter motor.
5. Measurement of Temperature using sensor.
6. Measurement of Pressure using sensor.
7. Measurement of Position using sensor.
8. Measurement of Oxygen using sensor.
9. Study of Air Management System under different operating conditions.
10. Study of effect of operating variables on injector's activating Pulses.
11. Study of functioning/working of Idle speed control system.
12. Study of effect of spark advances on the Engine Emissions.
13. Study of Idle Speed Control.
14. Study of Electro-magnetic fuel Injector.

Term Work

Term work shall consist of minimum 8 experiments from the list, 6 assignments covering maximum portion of the syllabus (one on each module).

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical/Oral examination

1. Practical examination is based on list of experiments proposed.
2. Demonstration of automobile electronic systems like Battery, Alternator, Dynamo, Starter Motors, Sensors etc
3. Distribution of marks for practical/oral examination shall be as follows:
   i. Practical performance: 15 marks
   ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed
5. Students work along with evaluation report to be preserved till the next examination

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Understanding Automotive Electronics by William B. Ribbens
2. Automobile Electrical & Electronics by Tom Denton.
3. Intelligent Vehicle Technologies by Michel Parent
4. Light weight Electric/Hybrid vehicle design by John Fenton & Ron Hodkinson
5. Computerized engine control by Dick King
6. Automotive electrical equipments by P.L.Kohli
7. Automotive Mechanics by William Crouse and Anglin.
8. Automotive Electronic Hand book by Ronald K. Jurgen
9. Car electronics (Second edition) edited by Shuji Mizutani.

Course Code	Course /Subject Name	Credits
AEC802	**Vehicle Dynamics**	**4+1**

Objective

1. To provide students with the fundamental knowledge in the field of automotive dynamics.

Outcome: Learner will be able to…..

1. Ability to design automotive component to meet desired needs.
2. Competence to apply the fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machine for actual design problems.
3. Develop analytical abilities to give solutions to automotive design problems.

Module	Details	Hrs
1	**Fundamentals of vehicle dynamics** Road loads, Aerodynamics - Drag, side force, Lift force, Rolling resistance, Total road loads, Ride, Vehicle response properties, Perception of ride. **Tyres** Tyre construction, Tractive properties, Cornering properties, Camber thrust, Aligning moment, Combined braking and cornering, Conicity and ply steer, Tire vibrations, Tyre properties affecting vehicle rollover	**10**
2	**Suspension systems** Fundamental approach to vehicle modeling, Single mass system with two degree of freedom, Theory and problems of double Conjugate points, Motion after the hump, Acceleration for stepped input, Solid axles, Independent suspensions, Anti- Squat and anti- pitch suspension geometry, Equalizing type of suspension, Active suspension, Semi Active.	**10**
3	Roll Center of suspension linkages, Roll axes and roll angles, Non- Roll layout, No Roll suspensions, **Vehicle Rollover** Characteristics of on road rollover, Rollover résistance, Anti rollover Braking, Anti- roll bar and its effects **Equation of Motion** Euler's equation of motion, Inertia tensor axes	**08**
4	**Steering Systems** Steering geometry, Front wheel geometry, Steering system forces and, moments, Steering system effects, Influence of front wheel drive, Four wheel steering, Steering oscillations, Shimmy & wheel wobble, Jack Knifing of articulated vehicles	**07**
5	**Handling characteristics** Steady state cornering, Low speed turning, High speed cornering, Stability derivatives (Derivation and problems), Suspension effect of cornering, Steady state and Transient behavior	**07**
6	**Recent trends in vehicle dynamics** Stability Control systems, Introduction of vehicle sensors, Central tyre, inflation systems, Influence of parameters at vehicle rollover, Vehicle dynamics simulations	**06**

List of Experiments

1. Mathematical modeling of suspension system (Quarter suspension model and half vehicle).
2. Live problem on suspension design of modern vehicle in passenger car segment, heavy vehicle segment etc

Term Work

Term work shall consist of experiments from the list, and minimum 6 assignments covering maximum portion of the syllabus (one on each module).

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Fundamentals of Vehicle Dynamics By Thomas. D. Gillespie.
2. Multibody Systems Approach to Vehicle Dynamics Mike Blundell and Damian Harty.
3. Mechanics of Road vehicle By Steeds.
4. Mechanics of vehicles By J.J. Taborelc.
5. Automobile suspension and Handling By Colin Campell.
6. Car suspension By Bastow.

Course Code	Course /Subject Name	Credits
AEC803	**Vehicle Maintenance**	**4+1**

Objectives

1. To study basics of vehicle maintenance
2. To study maintenance of vehicle systems and subsystems
3. To study different automotive diagnostic tools

Outcomes: Learner will be able to……

1. Effectively use automotive diagnostic tools in industries.
2. Improve existing vehicle maintenance practices in industries.

Module	Details	Hrs.
1	**Types of Maintenance** **Automotive Engine Diagnosis:** Lower End Theory and Service, Upper End Theory and Service, Engine Lubrication Diagnosis and Service, Cooling System Diagnosis	06
2	**Electrical System Diagnostic and Service** Batteries: Theory Diagnosis, and Service Starting System Diagnosis, and Service Charging Systems Basic Lighting System Diagnosis	10
3	**Electrical Accessories** Windshield Wiper/Washer Systems , Horns/Clocks/Cigarette Lighter Systems, Sound Systems , Power Lock Systems, Power Windows, Power Seats, Power Mirror System, Rear-Window Defrosters an Heated Mirror Systems, Other Electronic Equipment, Security and Antitheft Devices	06
4	**Restraint Systems: Theory, Diagnosis, and Service** Seat Belts , Seat Belt Service, Air Bags, Electrical System Components Diagnosis, Servicing the Air Bag System, Other Protection Systems	06
5	**Manual transmissions and transaxles** Clutch Problem Diagnosis and Service, Diagnosis of Drive Shaft and U-Joint Problems, Transmission/Transaxle Problem Diagnosis and Service, Servicing the Final Drive Assembly and Diagnosing Differential Noises	08
6	**Suspension And Steering Systems** Tire/Wheel Run out, Tire Replacement, Tire Repair, Installation of Tire/ Wheel Assembly on the Vehicle, Basic Front-Suspension Diagnosis and Service, Manual-Steering Systems and Power-Steering System Diagnosis and service, Alignment Geometry Performing an Alignment on Two wheel drive Four-Wheel-Drive Vehicle Alignment **Brakes** Drum Brake Inspection, Brake Shoes and Linings, Wheel Cylinder Inspection and Servicing, Drum Parking Brakes. Disc Brake Diagnosis and Service, General Caliper Inspection and Servicing, Rear Disc Brake Calipers, Antilock Brake System Diagnosis and Service	12

	Engine Performance OBD-II Self- Diagnostics, Basic Diagnosis of Electronic Engine Control Systems Using Scan Tool Data, Symptom-Based Diagnosis, Ignition System Diagnosis and Service, Fuel Injection System Diagnosis and Service, Emission Control Diagnosis and Service, EGR System Diagnosis and Service , Catalytic Converter Diagnosis, Air System Diagnosis and Service	

List of Experiments

1. To perform engine analysis of petrol & diesel engines using a computerized engine analyzer or Auto Master.
2. To perform wheel balancing on a computerized wheel balancer.
3. To find the steering geometry of a vehicle using a computerized wheel aligner
4. Removing and refitting of tyre using an automatic tyre changer.
5. Dismantling, inspection and repairing and assembly of engine components.
6. Experiment on calibration of the fuel injection pump.
7. Study of body repairing and reconditioning methods.

Term Work

Term work shall consist of 7 experiments from the list, and minimum 6 assignments covering maximum portion of the syllabus (one on each module).

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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. Practical examination duration is 2 hours.
2. Examination is based on experiments performed during the semester
3. Distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance: 15 marks
    ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed
5. Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Automotive Technology :A Systems Approach, 5e Jack Erjavec/Delmar Cengage Learning
2. Automotive Mechanics, William Crouse and Donald Anglin /TATA Mc Graw-hill
3. Automotive Technology, Joseph Heitner
4. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman
5. Automotive Engines: Theory and Servicing by J.D.Halderman & Mitchell/Pearson Education.

Course Code	Course/Subject Name	Credits
AEE 8021	**Noise, Vibrations and Harshness**	**3+1**

Objectives

1. To study basic concepts of noise, vibration and harshness and their effects
2. To study various methods of Vibration control
3. To study and analyze sounds and detection of noise from automobiles.

Outcomes: Learner will be able to…

1. Identify and analyze vibrations and noise coming out of automobiles
2. Investigate level of harm caused by noise and harshness and to provide measures to control it.

Module	Detailed Contents	Hrs.
01	1. **Basics of Vibrations:** 1.1 Basic Concepts 1.2 Mathematical Models 1.3 System characteristics and response 1.4 Single and Multi DOF systems	06
02	2. **Vibration control:** 2.1 Isolators 2.2 Tuned absorbers 2.3 Untuned viscous dampers 2.4 Applications: single cylinder engines, multi cylinder engine 2.5 Simple rubber engine mounts 2.6 Hydro elastic mounts 2.7 Semi active mounts and active mounts 2.8 Mass elastic models and measurements 2.9 Limits for passenger comforts	08
03	3. **Sound & sound measurement:** 3.1 Fundamentals of acoustics 3.1.1 General sound propagation 3.1.2 Plane wave propagation 3.1.3 Spherical wave propagation 3.2 Human response to sound – the audible range 3.3 Sound measurement 3.3.1 Instrumentation 3.3.2 Sound level meters 3.3.3 Frequency intensity analyzers 3.3.4 Real time measurements	08
04	4. **Automotive noise:** 4.1 Automotive noise criteria 4.1.1 Drive by noise test 4.1.2 Noise from stationary vehicles 4.1.3 Interior noise in vehicles 4.2 Automotive noise 4.2.1 Sources and control methods i) Engine noise ii) Transmission noise iii) Intake and exhaust noise iv) Aerodynamic noise v) Tyre noise vi) Brake noise	06

05	5. **General noise control principles** 5.1 Sound in enclosures 5.2 Sound energy absorption 5.3 Sound transmission through barriers	04
06	6. **Harshness** 6.1 Causes 6.2 Frequency limits	04

Term Work

Term work shall consist of at the list 6 assignments (one on each module) covering maximum portion of the syllabus.

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

- Assignments : **20 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Rao S S, "Mechanical Vibrations", Addison Wesley Longman, New Delhi, 1995.
2. Heinz Heisler, “Advanced Engine Technology”, SAE 1995.
3. “Automobiles and pollution” SAE Transaction, 1995.
4. Seto, “Mechanical Vibrations ", Schaum Outline Series, McGraw Hill Book Company, New York, 1990.
5. Springer and Patterson, “Engine Emission”, Plenum Press 1990.
6. Thomson W T, "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
7. Ashok Kumar Mallik, “Principles of Vibration control”, Affiliated East-West Press (P) Ltd., New Delhi, 1990.
8. Grover G K, "Mechanical Vibrations ", New Chand and Brothers, Roorkey, 1989.
9. Tse Morse and Hinkle, “Mechanical Vibration”, Prentice Hall of India Ltd., New Delhi,1987.

Course Code	Course/Subject	Credits
AEE 8022	**Vehicle Safety**	**3+1**

Objectives

1. To study basic concepts of vehicle safety
2. To study accident reconstruction analysis methods
3. To study different issues in vehicle safety

Outcomes: Learner will be able to……

1. Understand vehicle design from safety point of view
2. Apply the concepts of accident reconstruction analysis in real world

Module	Detailed Contents	Hrs.
01	**Introduction:** Introduction to vehicle safety, Basic concepts of vehicle safety, Risk evaluation and communication, Human error control, Universal design The distracted driver, Special design problems (Design for children, handicap, etc)	06
02	**Safety Regulations and testing:** Vehicle Safety Regulations, Accident Data, Accident Avoidance, Biomechanics and Occupant Simulation, Crash Testing, Vehicle Body Testing, Dynamic Vehicle Simulation Tests, Occupant Protection Pedestrian Protection, Compatibility, Interrelationship among Occupants, Restraint Systems, and Vehicle in Accidents	08
03	**Rear Crash Safety:** Head Restraint Position during Normal Driving, Study of procedure to evaluate Occupant Interaction with seat in rear crashes, Role of seat in Rear crash safety, Performance criteria for different seats, Ultra high Retention seats, Human and dummy responses for Pendulum impacts to the Back Effectiveness of Self –Aligning Head Restraints in preventing whiplash, Energy absorptions properties of Head Restraints, Introduction to RUPD (Rear under rum protection device)	08
04	**Accident Reconstruction Analysis:** Uncertainty in Measurement and cautions, Tire forces, Straight-line Motion Critical speed from Tire Yaw marks, Reconstruction of Vehicular Rollover Accidents, Analysis of Collisions , Impulse – Momentum Theory, Reconstruction Applications , Impulse Momentum Theory, Crush Energy Frontal Vehicle –Pedestrian Collusion, Photogrammetry for accident constructions	08
05	Working of different Automotive safety systems Recent trends in Automotive safety systems	04
06	Key issues in vehicle safety in India and Abroad	02

List of Experiments:

1. Measurement of Windscreen wiping area for different vehicles.
2. Study of Crash test dummies.
3. Measurement of Eye lids, H Point and R Point.
4. Calibration study of Speedometer and Odometer.
5. Study of Tell Tale Symbols in Indian Cars
6. Industrial Visit

Term Work

Term work shall consist of 5 experiments from the list, 6 assignments covering maximum portion of the syllabus (One on each module).

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **05 marks**
- Industrial visit report: **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Automotive vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
2. Understanding Automotive electronics by William Ribbens, Newnes, Sixth Edition, 2003.
3. Vehicle Accident Analysis and Reconstruction Methods by Raymond M. Brach and R. Matthew Brach, SAE International, Second Edition, 2011.
4. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
5. Automotive Safety Handbook by Ulrich W. Seiffert and Lothar Wech, SAE International, 2007.

Course Code	Course/Subject Name	Credits
AEE 8023	World Class Manufacturing[&]	3+1

[&] Common with Mechanical Engineering

Objectives

1. To familiarize the students with the concepts of Business excellence and competitiveness.
2. To apprise the students with the need to meet the current and future business challenges.
3. To prepare the students to understand the current global manufacturing scenario.

Outcomes: Learner will be able to..

1. Demonstrate the relevance and basics of World Class Manufacturing.
2. Identify the factors of competitiveness and performance measures based on which, global manufacturing success is bench marked
3. Draw current Status of Indian Manufacturing scenario and design and develop a roadmap to achieve world class manufacturing status.

Module	Details	Hrs.
01	**Historical Perspective** World class organizations: Meaning of world class. Competitiveness and Performance measures. Criteria for world class organizations in Manufacturing. Competing in World markets. Review of frameworks in World Class Manufacturing (WCM). Models for manufacturing excellence: Schonberger, Halls, Gunn & Maskell models and Business Excellence.	05
02	**Benchmark, Bottlenecks and Best Practices** Concepts of benchmarking, Bottleneck & best practices. Best performers, Gaining competitive edge through world class manufacturing, Value added manufacturing, Value Stream mapping, Eliminating different types of waste. Lean Thinking (Toyota Production System), Six Sigma, Theory of Constraints.	07
03	**System and Tools for World Class Manufacturing** Improving Product & Process Design: SQC, Statistical Process Control, Quality Function Deployment (QFD), Seven Basic Quality Tools, FMS, Poka Yoke, 5-S, Optimizing Procurement & stores practices, Total Productive maintenance and Visual Control.	07
04	**HR Dimensions in WCM – WCM Strategy Formulation** 4.1 Adding value to the organization: Organizational learning, techniques of removing Root cause of problems, People as problem solvers, New organizational structures. 4.2 Associates: Facilitators, Teams man ship, Motivation and reward in the age of continuous improvement.	05
05	**Characteristics of WCM Companies** Performance indicators like POP, TOPP and AMBITE systems. Other features of WCM : Supply Chain Management & key issues in SCM, Agile Manufacturing, Green Manufacturing, Role of Information system in WCM, Introduction to Knowledge management, Study of various performance measures in world class organization.	06
06	**Total Quality Management (TQM)** Definition, Understanding quality, Evolution of TQM, Framework for TQM, Commitment and leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance measures, Formulation and implementation of TQM: Case Study.	06

Term Work

Term work shall consist of at least six assignments on topics drawn from the syllabus [1 assignment per module] and at least 3 case studies and analysis based on the topics mentioned above.

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

- Assignments: **10** marks
- Lab work (Case Studies: at least 3, with inferences): **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. World Class Manufacturing – Strategic Perspective, Sahay B.S., Saxena K B C and Ashish Kumar, Mac Milan Publications, New Delhi.
2. World Class Manufacturing - The Lesson of Simplicity, Schonberger R. J, Free Press, 1986
3. Management strategy: achieving sustained competitive advantage, Marcus, A. A.,New York: McGraw-Hill/Irwin, 2011.
4. Manufacturing Strategy: Process and Content, Voss C. A., Chapman & Hall, London, 1992.
5. Lean production simplified, Pascal. D., 2nd Edition, Productivity Press, 2007
6. Total Quality Management, Besterfield, D. H., Pearson Education, 1999.
7. Advanced Operations Management, Mohanty R. P., Deshmukh S. G., Pearson Education,2003.
8. "Managing Technology and Innovation for Competitive Advantage", Narayanan V.K, Prentice Hall, 2000.
9. "Making Common Sense Common Practice – Models for manufacturing Excellence", Ron Moore, Butter worth Heinmann.
10. The Toyota Way – 14 Management Principles", Jeffrey K.Liker, Mc-Graw Hill, 2003. "Operations Management for Competitive Advantage", Chase Richard B., Jacob Robert., 11th Edition , McGraw Hill Publications, 2005.

Course Code	Course/Subject Name	Credits
AEE 8024	**Knowledge Management**	**3+1**

Objectives

1. To study basic concepts of knowledge management
2. To understand knowledge management tools and techniques

Outcomes: Learner will be able to…

1. Effectively implement knowledge management in organizations
2. Improve existing knowledge management practices in organizations

Module	Detailed Contents	Hrs.
01	**Introduction to Knowledge Management:** What Is Knowledge Management? Data ,information and knowledge, Types of knowledge, Forces Driving Knowledge Management, Knowledge Management Systems, Knowledge management systems and existing technology	02
02	**Principles of Knowledge Management** **2.1 Knowledge Management Foundations: Infrastructure, Mechanisms, and Technologies:** Knowledge Management Foundations, Knowledge Management Infrastructure, Knowledge Management Mechanisms, Knowledge Management Technologies, Management of Knowledge Management Foundations **2.2 Knowledge Management Solutions: Processes and Systems:** Knowledge Management Processes, Knowledge Management Systems, Managing Knowledge Management Solutions **2.3 Organizational Impacts of Knowledge Management:** Impact on People, Impact on Processes, Impact on Products, Impact on Organizational Performance	06
03	**Knowledge Management Technologies and systems** **3.1Knowledge Application Systems: Systems that Utilize Knowledge:** Technologies for Applying Knowledge, Developing Knowledge Application Systems, Types of Knowledge Application Systems, Limitations of Knowledge Application Systems **3.2 Knowledge Capture Systems: Systems that Preserve and Formalize** **Knowledge:** What Are Knowledge Capture Systems? Knowledge, Management Mechanisms to Capture Tacit Knowledge: Using Organization Stories, Techniques for Organizing and Using Stories in the Organization Designing the Knowledge Capture System, Concept Maps, Context-Based Reasoning, Barriers to the Use of Knowledge Capture Systems **3.3 Knowledge Sharing Systems: Systems that Organize and Distribute Knowledge:** What Are Knowledge Sharing Systems?, Designing The Knowledge Sharing System, Barriers to The Use of Knowledge Sharing Systems, Specific Types of Knowledge Sharing Systems, Lessons Learned Systems, Communities Of Practices (COP), Expertise Locator Knowledge Sharing Systems, The Role of Ontologies and Knowledge Taxonomies in the Development of Expertise Locator Systems, Shortcomings of Knowledge Sharing Systems 3.**4 Knowledge Discovery Systems: Systems that Create Knowledge:** Mechanisms to Discover Knowledge: Using Socialization to Create, New Tacit Knowledge, Technologies to Discover Knowledge: Using Data Mining to Create, New Explicit Knowledge, Designing the Knowledge Discovery System, Barriers to the Use of Knowledge Discovery Systems	10

04	**4.1 Emergent Knowledge Management Practices** **4.2 Factors Influencing Knowledge Management:** A Contingency View of Knowledge Management, The Effects of Task Characteristics, The Effects of Knowledge Characteristics, The Effects of Organizational and Environmental Characteristics, Identification of Appropriate Knowledge Management Solutions **4.3 Leadership and Assessment of Knowledge Management:** Leadership of Knowledge Management, Importance of Knowledge Management Assessment, Types of Knowledge Management Assessment, Assessment of Knowledge Management Solutions, Assessment of Knowledge, Assessment of Impacts	08
05	**The Future of Knowledge Management:** Using Knowledge Management as a Decision-Making Paradigm to Address Wicked Problems, Promoting Knowledge Sharing While Protecting Intellectual Property, Involving Internal and External Knowledge Creators, Addressing Barriers to Knowledge Sharing and Creation, KM for innovation	06
06	**Case studies in Knowledge Management**	04

List of Experiments

1. Case studies on knowledge Management
2. Group seminar (Group shall not be of more than 3 members)

Term Work

Term work shall consist of a case study, report of group seminar, 6 assignments covering maximum portion of the syllabus (one on each module).

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

- Case study**:** **10 marks**
- Seminar: **05 marks**
- Assignments : **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Encyclopedia of knowledge management by David Schwartz, publisher : Idea Group Reference
2. Knowledge Management Foundations by Steve Fuller,publisher: Butterworth–Heinemann.
3. KM tools and techniques : practitioners and experts evaluate KM solutions / Madanmohan Rao ,publisher Elsevier Butterworth–Heinemann
4. Knowledge management strategies for business development / Meir Russ, editor. Published by Business Science Reference
5. The Knowledge-Creating Company by Ikujiro Nonaka by Harvard Business Review.
6. The complete guide to knowledge management: a strategic plan to leverage your company's intellectual capital / Edna Pasher and Tuvya Ronen.
7. The Knowledge management Toolkit:Practical Techniques for building a Knowledge management System by Amrit Tiwana/ Pearson Education

Course Code	Course/Subject Name	Credits
AEE 8025	Project Management[&]	3+1

[&] Common with Mechanical Engineering

Objectives

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To apprise the students with the project management lifecycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to..

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference.

Module	Detailed Contents	Hrs.
01	**Project Management Foundations** Definition of project management, project manager and project. Project types, project phases and knowledge areas.	04
02	**Initiating Projects** How to get a project started; Your project sponsor and creating charter; The project team and team dynamics; running meetings	06
03	**Planning Projects** Project estimating and scheduling techniques. PERT, CPM, GANTT chart. Introduction to any one project scheduling software.	08
04	**Planning Projects** Risk planning methods; Cost planning; Communication plan and Final project plan.	04
05	**Executing Projects** 5.1 Team management; communicating and engaging with all stakeholders of the projects. **Controlling Projects** 5.2 Earned Value Management techniques for measuring your work completed; Using milestones for measurement; change requests and scope creep. Keeping up with the project, Updating the project, Project Issues management and Dealing with troubled projects.	08
06	**Closing the Project** Customer acceptance; completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	06

Term Work

Term work shall consist of,

1. Assignments: On topics drawn from syllabus [At least 1 assignment per module].
2. One scheduling exercise on any project management software where writing WBS and Scheduling on PMIS software for a simple project or a Case Study on project selection/ risk management.
3. Case Studies (at least 2 with inferences).

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

- Assignments: **10** marks
- Scheduling on PMIS software: **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Project Management and Control,Narendra Singh; Himalaya Publishing House
2. Preparation, Appraisal, Budgeting, Implementing and Review, Prasanna Chandra TMGH
3. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, Wiley India, 7th Ed.
4. Project Management, Dennis Lock, Gower Publishing England, 9th Ed.
5. Project Management, Gido Clements & Cengage Learning.
6. Project Management, Gopalan, Wiley India
7. Projects- Planning, Analysis, Selection, Financing, Implementation and Review, Prasanna Chandra, TMGH

Course Code	Course/Subject Name	Credits
AEE 8026	Artificial Intelligence	3+1

Objectives

1. Introduction to the basic concepts of Artificial Intelligence.
2. To develop the design and programming skills.
3. Implement, evaluate, and compare the performance of various AI Techniques.

Course Outcomes: Learner will be able to …..

1. Apply the concept in Automobile industry
2. Model and simulate real life problem of Automobile industries.

Module	Detailed Contents	Hrs.
01	**AI and Internal Representation** Artificial Intelligence and the World, Representation in AI, Properties of Internal Representation, The Predicate Calculus **Intelligent Agents:** Concept of Rational Agent, Structure of Intelligent agents, Agent Environments**.** **Problem Solving :** Solving problems by searching, Problem Formulation, Search Strategies, Uninformed Search Techniques, DFS, BFS, Uniform cost search, Iterative Deepening, Comparing different Techniques, Informed search methods – Best First Search, heuristic functions, Hill Climbing, A*.IDA*. Crypt Arithmetic, Bactracking for CSP	06
02	**Programming in LISP or PROLOG** Lisps, Typing at Lisp, Defining Programs, Basic Flow of Control in Lisp, Lisp Style, Atoms and Lists, Basic Debugging, Building Up List Structure, More on Predicates, Properties, Pointers, Cell Notation and the Internals (Almost) of Lisp, Destructive Modification of Lists, The for Function, Recursion, Scope of Variables Input/Output, Macros	06
03	**Fundamentals Concepts and Models of Artificial Neural Systems** Biological Neuron and their Artificial Models, Models of ANN, Learning and Adaptation, Neural Networking Learning Rules. Single-layer Perception Classifiers **Multilayer Feed forward Networks :** Linearly Nonseparable Pattern Classification, Delta Learning Rule, Feed forward Recall and Error Back-Propagation Training, Learning Factor	06
04	**Fuzzy Systems** **Fuzzy Sets: Fuzzy** Relations, Fuzzy Function, Fuzzy Measures, probabilities possibilities. Fuzzy Modeling and applications of Fuzzy Control. Neural and fuzzy machine Intelligence	06
05	**Generic Algorithm:** Simple generic algorithm, Simulation by hands, similarity templates (Schemata), Mathematical foundations, Schema processing at work, Two armed and k armed Bandit Problem, Building blocks hypothesis, Minimal Deceptive Problem, Computer implementation of generic algorithm, Data structures, Reproduction, Cross over and mutation. Time to response and time to cross mapping objective function to fitness from fitness scaling. Application of generic algorithm. De Jong and Function Optimization. Improvement in basic techniques, Improvement to genetics based machine learning, application of genetic based machine learning	06

06	**Data Mining & Information Retrieval** Data warehousing & Data Mining. Online Analytic Processing [OLAP]: its architecture and its use. Java implementations, classification trees and exploratory data analysis [EDA]. EDA Vs Hypothesis Testing, Computational EDA Techniques, Graphical [Data Visualization], EDA techniques for function fitting, data smoothing, layering, tessellations, contour projections, Verification of results of EDA. Applications & trends in data mining. Case Studies	**06**

Term Work

Term work shall consist of, Assignments on each module [At least 1 assignment per module]. The distribution of marks for term work shall be as follows:

1. Assignments: **20** marks
2. Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Introduction to Artificial intelligence By Eugene Charniak, Drew McDermott Addison Wesley
1. Artificial Neural Networks- B.Yegnanarayana, PHI, 1999.
2. Genetic Algorithms in search, Optimization & Machine Learning by David E Goldberg-Addison wesley
3. Data Mining by Pieter Adriaans and Dolt Zantinge - Pearson Education Asia
4. Data Warehousing in the Real World by Sam Anahory and Dennis Murray.
5. Artificial Intelligence, Elaine Rich, Kevin Knight, S. Nair, McGraw Hill Publishing Company Ltd
6. Principles of Artificial Intelligence – N.J. Nilsson, Tioga Hill, 1992.
7. Artificial Intelligence and Design of Expert Systems – C.F. Luger & W.A. Stubblefeild, Addison-Wesley.
8. Introduction to Data Mining & Knowledge Discovery – Edelstein, Herbert A.
9. Introduction to Artificial Neural Systems – Jacek M. Zurada, Jaico Publishing House, 2001.
10. Neural Network – SimsonHaykin, Macmillan Publication, 1994.
11. Fuzzy Set Theory & its Applications – H.J.Zimmermann, Allied Publishers Ltd, 1996.

Course Code	Course/Subject Name	Credits
AEE8027	Virtual Reality	3+1

Objectives

1. Introduction to the basic concepts of Virtual Reality.
2. To develop the design and programming skills.
3. Implement, evaluate, and compare the performance of various Virtual Reality Techniques

Outcomes: Learner will be able to….

1. Apply the concept in Automobile industry
2. Model and simulate real life problem of Automobile industries.

Module	Detailed Contents	Hrs.
01	**Introduction:** A short history of early virtual reality, early commercial VR Technology, VR becomes an Industry, The five classical components of VR Systems. **Input Devices: Trackers, Navigations and Gesture Interfaces.** Three Dimensional Position Trackers: Tracker performance parameters, Mechanical trackers, Magnetic trackers, Ultrasonic trackers, Optical Trackers and Hybrid Inertial Trackers Navigation and Manipulation Interfaces: Tracker based Navigation/Manipulation Interfaces, Trackballs, and three Dimensional Probes Gesture Interfaces: The Pinch Glove, the 5DT Data Glove, the Didjiglove, the Cyberglove	06
02	**Output Devices: Graphical, Three Dimensional Sound and Haptic Displays:** Graphical Display: The human visual system, personal graphics displays, large volume displays. Sound displays: the human auditory system, the convolvotron, Speaker based three dimensional sound. Haptic Feedback: The human haptic system, Tactile Feedback Interfaces, Force Feedback Interfaces.	06
03	**Computing Architectures for Virtual Reality:** The Rendering Pipeline: The graphical rendering pipeline, The haptics rendering pipeline. PC Graphics Architectures: PC Graphics Accelerators, Graphics Benchmarks. Work Station Based Architectures: the Sun Blade 1000 Architecture, The SGI Infinite Reality Architecture. Distributed VR Architectures: Multipipeline Synchronization, Colocated rendering Pipelines, Distributed Virtual Environments.	06
04	**Modeling:** Geometric Modeling: Virtual Object Shape, Object Visual Appearance. Kinematics Modeling: Homogeneous Transformation Matrices, Object Position, Transformation Invariants, Object Hierarchies, viewing the three dimensional words. Physical Modeling: Collision Detection, Surface Deformation, Force Computation, Force Smoothing and Mapping, Haptic Texturing. Behavior Modeling and Model Management: Level of Detail Management, Cell Segmentation.	06
05	**Virtual Reality Programming:** Toolkits and Scene Graphs. World Toolkit: Model Geometry and Appearance, The WTK Scene Graph, Sensors and Action Functions, WTK Networking, JAVA 3D: Model Geometry and Appearance, Java 3D Scene graph, Sensors and Behaviors, Java 3D Networking, WTK and Java 3D Performance Comparison. General Haptics Open Software Toolkit: GHOST Integration with the Graphics Pipeline, The GHOST Haptic Scene Graph, Collision Detection and response, Graphics and PHANToM	06

	Calibration. **Human Factors in Virtual Reality:** Methodology and Terminology: Data Collection and Analysis, Usability Engineering Methodology. User Performance Studies: Test bed Evaluation of universal VR Tasks, Influence of System Responsiveness on User Performance, Influence of Feedback Multimodality.	
06	**Traditional Virtual Reality Applications:** Medical Application of VR: Virtual Anatomy, Triage and Diagnostic and Rehabilitation. Education, Arts and Entertainment: VR in Education, VR and, Surgery the Arts. Entertainment Application of VR. Military VR Application: Army use of VR, VR Application in Navy, Air Force use of VR. **Emerging Application of VR:** VR Application and Manufacturing: Virtual Prototyping, other VR Application in Manufacturing; Application of VR in Robotics: Robot Programming, Robot Tele operation. Information Visualization: Oil Exploration and Well Management, Volumetric Data Visualization.	**06**

Term Work

Term work shall consist of, at least one (1) assignments on each module

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

- Assignments: **20** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

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.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. GrigoreBurdea, Philippe Coiffet, " Virtual Reality Technology" 2nd edition. Wiley India
2. John vince, "Virtual Reality Systems" Pearson Education Asia
3. Understanding Virtual Reality, Sherman, Elsever.

Course Code	Course/Subject Name	Credits
AEP701 / AEP802	**Project I/ II**	**3 / 6**

Objective

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of solving the problem in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Outcome: Learner will be able to…

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Breadth and depth of literature survey
- Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions