UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Automobile Engineering

Second Year with Effect from AY 2017-18
Third Year with Effect from AY 2018-19
Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's 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 (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are 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 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's 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 the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming sessions, which was attended by more than 40 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 motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process
4. To prepare the Learner for a successful career in Indian and Multinational Organisations

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view 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 stakeholders.

Dr. S. M. Khot

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

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC301	Applied Mathematics III**	04	--	04	--	04
AEC302	Thermodynamics*	04	--	04	--	04
AEC303	Strength of Materials*	04	--	04	--	04
AEC304	Production Process I*	04	--	04	--	04
AEC305	Material Technology*	03	--	03	--	03
AEL301	Computer Aided Machine Drawing*	--	$2^\$+4$	--	03	03
AEL302	Strength of Material*	--	02	--	01	01
AEL303	Material Technology*	--	02	--	01	01
AEL304	Machineshop Practice I*	--	04	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract/ Oral	Total
		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	--	--	100
AEC304	Production Process I*	20	20	20	80	03	--	--	100
AEC305	Material Technology*	20	20	20	80	03	--	--	100
AEL301	Computer Aided Machine Drawing*	--	--	--	--	--	50	50	100
AEL302	Strength of Material*	--	--	--	--	--	25	25	50
AEL303	Material Technology*	--	--	--	--	--	25	--	25
AEL304	Machineshop Practice I*	--	--	--	--	--	50	--	50
Total				**100**	**400**		**150**	**75**	**725**

*Common with Automobile Engineering

**Common with Automobile Engineering, Production Engineering and Civil Engineering

$^\$$Theory for entire class to be conducted

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC401	Applied Mathematics IV**	04	--	04	--	04
AEC402	Fluid Mechanics*	04	--	04	--	04
AEC403	Industrial Electronics*	03	--	03	--	03
AEC404	Production Process II*	04	--	04	--	04
AEC405	Kinematics of Machinery*	04	--	04	--	04
AEL401	Data Base and Information Retrival*	--	$2^\$+2$	--	02	02
AEL402	Fluid Mechanics*	--	02	--	01	01
AEL403	Industrial Electronics*	--	02	--	01	01
AEL404	Kinematics of Machinery*	--	02	--	01	01
AEL405	Machine Shop Practice II*	--	04	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
AEC401	Applied Mathematics IV**	20	20	20	80	03	--	--	100
AEC402	Fluid Mechanics*	20	20	20	80	03	--	--	100
AEC403	Industrial Electronics*	20	20	20	80	03	--	--	100
AEC404	Production Process II*	20	20	20	80	03	--	--	100
AEC405	Kinematics of Machinery*	20	20	20	80	03	--	--	100
AEL401	Data Base and Information Retrival*	--	--	--	--	--	50	50	100
AEL402	Fluid Mechanics*	--	--	--	--	--	25	25	50
AEL403	Industrial Electronics*	--	--	--	--	--	25	25	50
AEL404	Kinematics of Machinery*	--	--	--	--	--	25	--	25
AEL405	Machine Shop Practice II*	--	--	--	--	--	50	50	100
Total				**100**	**400**		**175**	**150**	**825**

*Common with Automobile Engineering

**Common with Automobile Engineering, Production Engineering and Civil Engineering

$Theory for entire class to be conducted

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC501	Internal Combustion Engines*	04	--	04	--	04
AEC502	Mechanical Measurements and Control*	04	--	04	--	04
AEC503	Heat Transfer*	04	--	04	--	04
AEC504	Automotive Systems	03	--	03	--	03
AEDLO 501X	Department Level Optional Course I	04	--	04	--	04
AEL501	Internal Combustion Engines*	--	02	--	01	01
AEL502	Mechanical Measurements and Control*	--	02	--	01	01
AEL503	Heat Transfer*	--	02	--	01	01
AEL504	Automotive Systems	--	02	--	01	01
AEL505	Manufacturing Sciences Lab*	--	02	--	01	01
AEL506	Business Communication and Ethics*	--	$2^\$+2$	--	02	02
Total		**19**	**14**	**19**	**07**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
AEC501	Internal Combustion Engines*	20	20	20	80	03	--	--	100
AEC502	Mechanical Measurements and Control*	20	20	20	80	03	--	--	100
AEC503	Heat Transfer*	20	20	20	80	03	--	--	100
AEC504	Automotive Systems	20	20	20	80	03	--	--	100
AEDLO 501X	Department Level Optional Course I*	20	20	20	80	03	--	--	100
AEL501	Internal Combustion Engines*	--	--	--	--	--	25	25	50
AEL502	Mechanical Measurements and Control*	--	--	--	--	--	25	25	50
AEL503	Heat Transfer*	--	--	--	--	--	25	25	50
AEL504	Automotive Systems	--	--	--	--	--	25	25	50
AEL505	Manufacturing Sciences Lab*	--	--	--	--	--	25	--	25
AEL506	Business Communication and Ethics*	--	--	--	--	--	50	--	50
Total				**100**	**400**		**175**	**100**	**775**

Course Code	Department Level Elective Course I
AEDLO5011	Press Tool Design*
AEDLO5012	Machining Sciences and Tool Design*
AEDLO5013	Design of Jigs and Fixtures*

*Common with Mechanical Engineering
$^\$$ Theory for entire class to be conducted

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC601	Chassis and Body Engineering	04	--	04	--	04
AEC602	Machine Design I*	04	--	04	--	04
AEC603	Finite Element Analysis*	04	--	04	--	04
AEC604	Mechanical Vibrations	04	--	04	--	04
AEDLO 602X	Department Level Optional Course II	04	--	04	--	04
AEL601	Chassis and Body Engineering	--	02	--	01	01
AEL602	Machine Design I*	--	02	--	01	01
AEL603	Finite Element Analysis*	--	02	--	01	01
AEL604	Mechanical Vibrations	--	02	--	01	01
AEL605	Mechatronics Lab	--	02	--	01	01
Total		**20**	**10**	**20**	**05**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
AEC601	Chassis and Body Engineering	20	20	20	80	03	--	--	100
AEC602	Machine Design I*	20	20	20	80	03	--	--	100
AEC603	Finite Element Analysis*	20	20	20	80	03	--	--	100
AEC604	Mechanical Vibrations	20	20	20	80	03	--	--	100
AEDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100
AEL601	Chassis and Body Engineering	--	--	--	--	--	25	25	50
AEL602	Machine Design I*	--	--	--	--	--	25	--	25
AEL603	Finite Element Analysis*	--	--	--	--	--	25	25	50
AEL604	Mechanical Vibrations	--	--	--	--	--	25	25	50
AEL605	Mechatronics Lab	--	--	--	--	--	25	25	50
Total				**100**	**400**		**125**	**100**	**725**

Course Code	Department Level Optional Course II
AEDLO6021	Mechatronics
AEDLO6022	Robotics
AEDLO6023	Automotive Materials

*Common with Mechanical Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC701	Automotive Design	04	--	04	--	04
AEC702	CAD/CAM/CAE*	04	--	04	--	04
AEC703	Autotronics	04	--	04	--	04
AEDLO 703X	Department Level Optional Course III	04	--	04	--	04
ILO701X	Institute Level Optional Course I#	03	--	03	--	03
AEL701	Automotive Design	--	02	--	01	01
AEL702	CAD/CAM/CAE*	--	02	--	01	01
AEL703	Autotronics	--	02	--	01	01
AEP701	Project I	--	06	--	03	03
Total		**19**	**12**	**19**	**06**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
AEC701	Automotive Design	20	20	20	80	03	--	--	100
AEC702	CAD/CAM/CAE*	20	20	20	80	03	--	--	100
AEC703	Autotronics	20	20	20	80	03	--	--	100
AEDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I#	20	20	20	80	03	--	--	100
AEL701	Automotive Design	--	--	--	--	--	25	25	50
AEL702	CAD/CAM/CAE*	--	--	--	--	--	25	25	50
AEL703	Autotronics	--	--	--	--	--	25	25	50
AEP701	Project I	--	--	--	--	--	50	--	50
Total				**100**	**400**		**125**	**75**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
AEDLO7031	Automotive NVH	ILO7011	Product Lifecycle Management
AEDLO7032	Automotive Embedded Systems	ILO7012	Reliability Engineering
AEDLO7033	Automotive Aerodynamics and Aesthetics	ILO7013	Management Information System
AEDLO7034	Computational Fluid Dynamics*	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

*Common with Mechanical Engineering

 # Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC801	Vehicle Maintenance	03	--	03	--	03
AEC802	Vehicle Dynamics	04	--	04	--	04
AEC803	Vehicle Safety	03	--	03	--	03
AEDLO 804X	Department Level Optional Course IV	04	--	04	--	04
ILO802X	Institute Level Optional Course II#	03	--	03	--	03
AEL801	Automotive Workshop	--	04	--	02	02
AEL802	Vehicle Dynamics	--	02	--	01	01
AEP801	Project II	--	12	--	06	06
Total		**17**	**18**	**17**	**09**	**26**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract/ Oral	Total
		Test1	Test 2	Avg					
AEC801	Vehicle Maintenance	20	20	20	80	03	--	--	100
AEC802	Vehicle Dynamics	20	20	20	80	03	--	--	100
AEC803	Vehicle Safety	20	20	20	80	03	--	--	100
AEDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II#	20	20	20	80	03	--	--	100
AEL801	Automotive Workshop	--	--	--	--	--	25	25	50
AEL802	Vehicle Dynamics	--	--	--	--	--	25	25	50
AEP801	Project II	--	--	--	--	--	50	100	150
Total				**100**	**400**		**100**	**150**	**750**

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
AEDLO8041	Hybrid Electric and Fuel cell Vehicles	ILO8021	Project Management
AEDLO8042	Rapid Prototyping*	ILO8022	Finance Management
AEDLO8043	Product Design and Development	ILO8023	Entrepreneurship Development and Management
AEDLO8044	Transport Management and Motor Industry	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

*Common with Mechanical Engineering

 # Common with all branches

Course Code	Course Name	Credits
MEC301	**Applied Mathematics III****	**04**

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

Outcomes: Learner will be able to…
1. Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations
2. Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations
3. Solve initial and boundary value problems involving ordinary differential equations
4. Identify the analytic function, harmonic function, orthogonal trajectories
5. Apply bilinear transformations and conformal mappings
6. Identify the applicability of theorems and evaluate the contour integrals.

Module	Detailed Contents	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) $L\{t^n f(t)\}, L\left\{\dfrac{f(t)}{t}\right\}, L\left\{\displaystyle\int_0^t f(u)\,du\right\}, L\left\{\dfrac{d^n f(t)}{dt^n}\right\}$ Laplace Transform. of Periodic functions 1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof). 1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable	**12**
2	**Complex variables:** 2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions fo $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 2.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories **2.3** Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation	**08**
3	**Complex Integration:** 3.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic functions(without proof)Cauchy's integral formula (without proof))Singularities and poles: 3.2 Taylor's and Laurent's series development (without proof) 3.3 Residue at isolated singularity and its evaluation 3.4 Residue theorem, application to evaluate real integral of type $\displaystyle\int_0^{2\pi} f(\cos\theta, \sin\theta)\,d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x)\,dx$	**08**
4	**Fourier Series:** 4.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π and $2l$	**10**

	4.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parsvel's identities (without proof) 4.3 Complex form of Fourier series	
5	**Partial Differential Equations:** 5.1. Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method). 5.2. Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 5.3. Heat equation, steady-state configuration for heat flow 5.4. Two and Three dimensional Laplace equations	**09**
6	**Correlation and curve fitting** 6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems 6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Course Code	Course Name	Credits
AEC302	**Thermodynamics***	**04**

* Course common to Mechanical and Automobile Engineering

Objectives
1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize application of the concepts of thermodynamics in vapour power, gas power cycles

Outcomes: Learner will be able to…
1. Demonstrate application of the laws of thermodynamics to wide range of systems.
2. Write steady flow energy equation for various flow and non-flow thermodynamic systems
3. Compute heat and work interactions in thermodynamics systems
4. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
5. Use steam table and mollier chart to compute thermodynamics interactions
6. Compute efficiencies of heat engines, power cyclesetc.

Module	Detailed Contents	Hrs
01	**Basic Concepts & definitions:** Thermodynamics and its importance, Macroscopic and Microscopic view point, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Control Volume approach and Systems approach, Equilibrium – Thermal ,Chemical, Mechanical and thermodynamic, Pure Substance, Property – Intensive and Extensive, State, Path, Process and Cycle. Point Function and Path Function, Quasi Static Process and processes like Isobaric, Isochoric, Isothermal, Polytropic Process, Temperature and different scales, Zeroth Law of Thermodynamics, Energy, sources of energy; forms of energy, Energy transfer by work and forms of work ; free Expansion, Energy transfer by heat ; Adiabatic Process, Equations of state, Ideal gas Equation-; Specific gas constant and Universal Gas Constant	08
02	**First Law of Thermodynamics:** Relation between Heat and Work- Joules Constant, First law of thermodynamics for a cyclic process, First law of thermodynamics for a closed system undergoing a process, Conservation principle, First Law of Thermodynamics applied to open system – Steady Flow Energy Equation, Perpetual motion Machine of First kind, Application of first law of thermodynamics to closed system or Non flow Process, Application of first law of thermodynamics to Open Systems like Steam Nozzle, Boiler, Steam Turbine, Pump, Heat Exchanger, Throttling Process – Joules Thompson Coefficient and its significance	07
03	**Second Law of Thermodynamics:** Limitation of first law of thermodynamics, Thermal Reservoir – Source and Sink, Concept of Heat Engine, Heat Pump and Refrigerator, Second law of thermodynamics – Kelvin Planck and Clausius Statements. Equivalence of Clausius and Kelvin Planck Statement, Reversible and Irreversible Process. Causes of Irreversibility, Perpetual Motion Machine of Second Kind, Need of Carnot theorem and its corollaries, Carnot cycle, Thermodynamic Temperature Scale and its equivalence with Ideal Gas Scale **Entropy:** Clausius Inequality, Clausius Theorem, Entropy is Property of a system, Isentropic Process, Temperature Entropy Plot and its relationship with heat interactions, Entropy Principle, Entropy change During a Process. Interpretation of concept of entropy	07
04	**Thermodynamic Relations:** Reciprocal Relation, Cyclic Relation Property relations, Maxwell Relations, TdS equations, Heat capacity relations, Volume Expansivity, Isothermal Compressibility, Clausius-Clapeyron Equation **Availability:**	10

	High grade and Low Grade Energy, Available and Unavailable Energy, Dead State, Available energy with respect to a process and a cycle, Decrease of Available Energy When heat is transferred through a finite temperature Difference, Second Law efficiency **Properties of Pure Substance:** Pure substance and Phase changes: Phase change processes of pure substance, Property diagrams for phase change process (T-v, T-s and p-h diagrams), Understanding of Steam Table and Mollier chart with suitable examples.	
05	**Compressors:** Reciprocating Air Compressor, Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressors – Constructional details of multistage compressors, Need of multistage, Computation of work done, Volumetric efficiency, Condition for maximum efficiency, Inter cooling and after cooling (numericals), Theoretical and actual indicator diagram for multi stage compressors Rotary Air Compressors- Classification, Difference between compressors and blowers, Working and constructional details of roots blower, Screw type and vane type compressors	08
06	**Vapour Power cycle:** Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Methods to improve thermal efficiency of Rankine cycle – Reheat cycle and Regeneration Cycle. **Gas Power cycles:** Assumptions of Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Brayton Cycle, Sterling Cycle and Ericsson Cycle and Lenoir cycle and Atkinson cycle	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael ABoles,7[th]edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Longman Publishers Engineering
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 5th edition, TMH
5. Thermodynamics by Onkar Singh, New Age International
6. Thermodynamics by C P Arora, TMH
7. Thermodynamics by R K Rajput, Laxmi Publications
8. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press(India) Pvt Ltd
9. Fundamentals of Thermodynamics by Moran & Shapiro
10. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., JohnWiley & Sons
11. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
12. Thermodynamics by J PHolman, McGraw-Hill & Co

Course Code	Course Name	Credits
AEC303	**Strength of Materials***	**04**

Objectives:

1. To study different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. To study distribution of various stresses in the mechanical elements or bodies of finite dimensions that deform under loads.
3. To study the effects of component dimensions, materials and shapes on stresses and deformations

Outcomes: Learner should be able to……
1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the stresses induced in basic mechanical components.
4. Estimate the strain energy in mechanical elements.
5. Analyse the deflection in beams.
6. Analyse buckling and bending phenomenon in columns, struts and beams.

Module	Detailed Contents	Hrs
1	**Moment of Inertia:** Area moment of Inertia, Principal Axes and Principal Moment of Inertia, , Parallel Axis theorem, Polar moment of Inertia. **Stresses and Strains:** Definition – Stress, Strain, Hooke's law, elastic limit, uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress, Principal stresses and strains, Mohr's circle. **Elastic Constants:** Poisson'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 and strain.	12
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.	08
3	**Stresses in Beams:** Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength, Flitched beams. **Direct and Bending Stresses:** Core of sections, Chimneys subjected to wind pressure. **Shear Stress in Beams:** Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.	08
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 gradual, sudden and impact loads. Strain energy due to shear, bending and torsion. **Deflection of Beams:**	08

5	Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings. **Thin Cylindrical and Spherical Shells:** Cylinders and Spheres due to internal pressure. Cylindrical shell with hemi spherical ends.	08
6	**Columns and Struts:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula	4

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
2. Strength of Materials by Ryder, Macmillan
3. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, Sixth Edition, 2009
4. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
5. Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers,New Delhi
6. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
7. Mechanics of Materials byBeer, Jhonston, DEwolf and Mazurek, TMHPvt Ltd., New Delhi
8. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
9. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
10. Introduction to Solid Mechanics by Shames, PHI
11. Strength of Materials by Nag and Chandra, Wiley India
12. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
13. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition

Course Code	Course Name	Credits
AEC304	**Production Process I***	**04**

Objectives

1. To study basic production processes.
2. To study how to select appropriate production processes for a specific application.
3. To study machine tools

Outcomes: Learner should be able to**:**
1. Demonstrate understanding of casting process
2. Illustrate principles of forming processes
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Distinguish between the conventional and modern machine tools.

Module	Detailed Contents	Hrs
1.	**1.1 Metal casting:** Classification of Production Processes: Examples and field of applications Pattern materials and allowances, Types of pattern, Sand properties, Sand moulding, Machine moulding Gating system :Types of riser, types of gates, solidification Melting- cupola& induction furnaces **1.2 Special casting processes** : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	**10**
2.	**2.1 Joining processes:** Welding: Classification of welding, Oxy-acetylene welding, types of flames, equipment used, welding methods & applications, Arc welding principle and working of metal arc welding, TIG & MIG welding, submerged arc welding, electro-slag welding & stud welding PAM welding. Applications merits & demerits of above welding processes, fluxes used, Thermit welding, Resistance welding, Friction welding, ultrasonic, explosive, LASER, electron beam welding, Welding defects and remedies Soldering and brazing techniques & applications Fastening processes	**10**
3.	**3.1 Forming processes:** Principles and process characteristics, Rolling types, Rolling parameters: Draught, spread, elongation, roll pressure, torque, work and power in rolling. Effect of front and back tension on rolling load and capacities,Rolling defects,Thread rolling roll forging, production of seamless tubes, Forging,Extrusion and Wire Drawing processes	**08**
4.	**4.1 Moulding with polymers:** Moulding with polymers: Basic concepts related to Injection Moulding, Compression moulding, Transfer moulding, Blow Moulding, Rotational Moulding, Thermoforming and Extrusion. Applications of plastics in Engineering field **4.2 Moulding with ceramics**: Blow moulding and extrusion of glass.	**06**
5.	**Classification, Selection and application of Machine Tools:** **5.1** Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines, Broaching machines, Lapping/Honing machines and shaping/slotting/planning Machines. **5.2** Gear Manufacturing -Gear milling, standard cutters and limitations, gear hobbing, gear shaping, gear shaving and gear grinding processes	**10**
5	**5.1 Modern Machine Tools:** CNC machines: Introduction, principles of operation, Types – Vertical machining centres and horizontal machining centres, major elements, functions, applications, controllers, open loop and closed loop systems **5.2** Types of automatic machines, Transfer machines	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References

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, Prentice Hall
6. Production Technology by HMT
7. Elements of Workshop Technology Hazra Chaudhary Vol I, II.
8. Foundry technology by P.L. Jain
9. Production Technology by P.C. Sharma
10. Manufacturing processes by P. N. Rao, Vol. 1 and 2

Course Code	Course Name	Credits
AEC305	Material Technology*	03

Objectives
1. To study basic engineering materials, their structure-property-performance
2. To study strengthening processes including heat treatment processes in order to enhance properties.
3. To study new materials and their applications

Outcomes: Learner will be able to ….
1. Identify various crystal imperfections, deformation mechanisms, and strengthening mechanisms
2. Demonstrate understanding of various failure mechanisms of materials.
3. Interpret Iron-Iron carbide phase diagram, and different phases in microstructures of materials at different conditions.
4. Select appropriate heat treatment process for specific applications.
5. Identify effect of alloying elements on properties of steels
6. Illustrate basics of composite materials, Nano- materials and smart materials.

Module	Detailed Contents	Hrs
1	**1.1 Classification of Materials:** Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples **1.2 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. **1.3 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 systems. **1.4 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	08
2	**Failure mechanisms:** **1.1 Fracture:** Definition and types of facture, Brittle fracture: Griffith's theory of fracture, Orowan's modification, Dislocation theory of fracture, Critical stress and crack propagation velocity for brittle fracture, Ductile fracture: Notch effect on fracture, Fracture toughness, Ductility transition, Definition and significance **1.2 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. **1.3 Creep:** Definition and significance of creep, Effect of temperature and creep on mechanical behaviours of materials, Creep testing and data presentation and analysis, Mechanism and types of creep, Analysis of classical creep curve and use of creep rate in designing of products for load bearing applications, Creep Resistant materials	08

3	**3.1 Theory of Alloys& Alloys Diagrams :** Significance of alloying, Definition, Classification and properties of different types of alloys, Solidification of pure metal, 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, TTTdiagram, CCT diagram Hardenability concepts and tests, Graphitization of Iron- Grey iron, white iron, Nodular and malleable irons, their microstructures, properties and applications	08
4	**4.1 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. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes	06
5	**5.1 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 phase transformation Classification of tool steels and metallurgy of tool steels and stainless steel	04
6	**Introduction to New materials:** **6.1** Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications **6.2** Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites **6.3** An overview to Smart materials (e.g.: Rheological fluids)	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References
1. Materials Science and Engineering by William D. Callister, Jr. – Adapted by R.Balasubramaniam, Wiley India (P) Ltd
2. Material Science and Metallurgyby V.D. Kodgire, Everest Publishing House
3. Mechanical Behaviour of Materials by Courtney, McGraw Hill International New Delhi
4. Introduction of Engineering Materials, by B.K. Agrawal, McGraw Hill Pub. Co. ltd
5. Mechanical Metallurgy by G.E. Dieter, McGraw Hill International New Delhi
6. A text book of Metallurgy by A.R.Bailey, Macmillan & Co. Ltd., London
7. The Structure and Properties of Engineering Alloys by W.F. Smith, McGraw hill Int.
8. Engineering Physical Metallurgy, by Y. Lakhtin, Mir Publishers, Moscow
9. Introduction to Physical Metallurgy by SydneyAvner, McGraw Hill
10. Metallurgy for Engineers by E.C. Rollason - ELBS SOC and Edward Arnold, London

Course Code	Course Name	Credits
AEL301	**Computer Aided Machine Drawing***	**03**

Objectives:
1. To familiarise conversion of an object into a drawing
2. To study 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. Read and interpret the drawing
3. Draw details and assembly of different mechanical systems.
4. Convert detailed drawing into assembly drawing using modelling software
5. Convert assembly drawing into detailed drawing using modelling software
6. Prepare detailed drawing of any given physical object/machine element with actual measurements

Module	Detailed Contents	Theory	Practical
1	**1.1 Machine Elements:** Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc)	02	04
	1.2 Conventional representation of threaded parts, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components	01	--
	1.3 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	04	--
2	**2.1 Geometric Dimensioning and Tolerancing (GD&T)** : Dimensioning with tolerances indicating various types of fits,	02	--
	2.2 Details and assembly drawing: Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards,	02	--
	2.3 Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa,		
	2.4 Preparation of details and assembly drawings of *any three* from: Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures	02	08
	2.5 Cotter, Knuckle joint, Keys: keys-sunk, parallel woodruff, saddle, feather etc.	01	--
	2.6 Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling	02	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, Pedestal bearing, footstep bearing	02	06
4	**4.1 Preparation of details and assembly drawings of pulleys, Pipe joints:** Classification of Pulleys, pipe joints	02	--
	4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys.	--	06
	4.3 Pipe joints(*any two)*: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint	--	06
5	**5.2 Preparation of details and assembly drawings of Valves, I.C. Engine parts:** Types of Valves, introduction to I.C. Engine	02	--
	5.3 Preparation of details and assembly drawings(*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, Carburettor, Fuel pump, injector, and Spark plug	--	08

6	**6.1 Reverse Engineering of a physical model**: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions	02	06

Assessment:

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 any 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   10 marks

End Semester Practical/Oral examination:
To be conducted by pair of Internal and External Examiner
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

References:
1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing byLaxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine DrawingbyKamat and 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 and SurinderRaina, Dreamtech Press
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

Course Code	Course Name	Credits
AEL302	**Strength of Materials***	**01**

Objectives:

1. To familiarise material behaviour under different loading conditions

2. To acquaint with surface hardness measurement method

3. To familiarise with impact test methods for different materials

Outcomes: Learner will be able to....

1. Analyse the stress - strain behaviour of materials

2. Measure ultimate tensile/compression strength of material

3. Measure torsional strength of material

4. Perform impact test using Izod and Charpy method

5. Measure the hardness of materials.

6. Perform flexural test with central and three point loading conditions

a) List of Experiments (Minimum Eight)

Module	Detailed Contents	Laboratory Sessions
1	Tension test on mild steel bar (stress-strain behavior, determination of yield strength & modulus of elasticity)	2 Hrs
2	Bending test on UTM	2 Hrs
3	Torsion test on mild steel bar / cast iron bar	2 Hrs
4	Impact test on metal specimen (Izod test)	2 Hrs
5	Impact test on metal specimen (Charpy test)	2 Hrs
6	Hardness test on metals - Brinell Hardness Number	2 Hrs
7	Hardness test on metals - Rockwell Hardness Number	2 Hrs
8	Flexural test on beam (central loading)	2 Hrs
9	Flexural test on beam (three point loading)	2 Hrs

b) Assignments: Atleast one problem on each of the following topics:

      1. Simple stress strain

      2. SFD and BMD

      3. Stresses in beams

      4. Strain energy and deflection.

      5. Torsion, Columns and struts

Note: Preferably, the assignments shall be based on live problems. Project Based Learning may be incorporated by judiciously reducing number of assignments.

Assessment:

Term Work: Including Part a and b both

Distribution of marks for Term Work shall be as follows:

      Part a   :   15marks.

      Part b   :   05 Marks

      Attendance   :   05 marks.

End Semester Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral

Course Code	Course Name	Credits
AEL303	**Materials Technology***	**03**

Objectives:
1. To familiarise with use of optical laboratory microscope
2. To acquaint with microstructures of ferrous (steel and cast iron) metals
3. To familiarise with microstructures of steel under different heat treated conditions
4. To study hardenability, fatigue test for fatigue strength and corrosion rate test

Outcomes: Learner will be able to …
1. Demonstrate the understanding of the procedure to prepare samples for studying microstructure using microscope (metallography)
2. Interpret different phases present in different plain carbon steels and cast irons.
3. Perform different heat treatment processes for a steel and observe microstructures in these conditions
4. Identify effects of Annealing, Normalizing and Hardening on microstructure of medium carbon steel
5. Determine hardenability of steel using Jominy end Quench test
6. Determine S-N curve by Fatigue Test.

Sr No	Details
1	Study of metallurgical microscope
2	Metallographic sample preparation and etching
3	Microstructures of plain carbon steels
4	Microstructures of cast irons
5	Annealing, Normalizing and Hardening of medium carbon steel and observation of microstructures
6	Study of tempering characteristics of hardened steel
7	Determination of hardenability of steel using Jominy end Quench Test
8	Fatigue test – to determine number of cycles to failure of a given material at a given stress

Assignments: Assignment on following topics

1. Crystal imperfections-deformation-strengthening mechanisms
2. Fracture-failure of metals
3. Iron –Iron carbide phase diagram/TTT diagram/CCT diagram.
4. Heat treatment processes
5. Alloy steels (e. g. alloy steels, tool steels)
6. New materials

Note: Preferably, the assignments shall be based on live problems. Project Based Learning may be incorporated by judiciously reducing number of assignments.

Assessment:

Term Work: Including Laboratory Work and Assignments both
Distribution of marks for Term Work shall be as follows:
Laboratory work   15 marks
Assignments   05 Marks

Course Code	Course Name	Credits
AEL304	**Machine Shop Practice I***	**02**

Objectives:

1. To study basic machining processes.

2. To familiarise 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, and screw cutting etc. on lathe machine.

3. Perform machining operations on shaper.

4. Demonstrate metal joining process like compressive welding.

5. Perform forging operations

6. Perform shaping operations

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

Assessment:

Term Work:

1. All the jobs mentioned above

2. Complete Work-Shop Book giving 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 …….**10** marks

Course Code	Course Name	Credits
MEC401	**Applied Mathematics IV****	**04**

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, complex integration, probability, test of hypothesis and correlation between data.
4. To prepare students for competitive exams

Outcomes: Learner will be able to…
1. Solve the system of linear equations using matrix algebra with its specific rules
2. Demonstrate basics of vector calculus
3. Apply the concept of probability distribution and sampling theory to engineering problems
4. Apply principles of vector calculus to the analysis of engineering problems
5. Identify, formulate and solve engineering problems
6. Illustrate basic theory of correlations and regression

Module	Details	Hrs
1	**Matrices:** 1.1 Brief revision of vectors over a real field, inner product, norm of a vector 1.2 Eigen values and Eigen vectors: 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) . Similarity of matrices. Functions of a square matrix	**08**
2	**Matrices:** 2.1 Minimal polynomial and Derogatory matrix 2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors **Vector calculus** 2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function 2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral	**09**
3	**Vector calculus:** 3.1 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) **Linear Programming problems** 3.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P	**09**
4	**Linear Programming problems Probability Distributions:** 4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P. **Probability Distributions** 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.3 Probability Distributions: Binomial, Poisson and Normal Distributions	**09**
5	**Sampling theory:** 5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical	**09**

	5.2. region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples	
	5.3. Test of significance for Large 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.	
	5.4. 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	
6	**Sampling theory and ANOVA** 6.1. Chi-square test, Test for the Goodness of fit , Association of attributes and Yate's correction 6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)	**08**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References:

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

Course Code	Course Name	Credits
AEC402	Fluid Mechanics*	04

Objectives:

1. To study fluid statics and fluid dynamics
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.

Outcomes: Learner should be able to ….

1. Define properties of fluids and classification of fluids
2. Evaluate hydrostatic forces on various surfaces and predict stability of floating bodies
3. Formulate and solve equations of the control volume for fluid flow systems
4. Apply Bernoulli's equation to various flow measuring devices
5. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces
6. Apply fundamentals of compressible fluid flows to relevant systems

Module	Detailed Contents	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	06
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	06
3	**3 Fluid Dynamics:** 3.1 Integral equations for the control volume: Reynold's Transport theorem, 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, 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 (HagenPoiseuille 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	08
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,	08

	laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers (without proof), 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	**08**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:

1. Fluid Mechanics byYunus A Cengel and John M Cimbala, McGraw Hill Education, 3rd Edition
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press
3. Introduction to Fluid Mechanics: Fox and McDonald
4. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition
5. Fluid Mechanics by F.M.White, McGraw Hill
6. Fluid Mechanics: K.L.Kumar
7. Introduction to Fluid Mechanics: James A.Fay
8. Fluid Mechanics: B.M.Massey
9. Mechanics of Fluids: Irving Shames
10. Fluid Mechanics and Hydraulics, S. K. Ukarande, Ane Books Pvt.Ltd

Course Code	Course Name	Credits
AEC 403	Industrial Electronics*	3

Objectives

1 To study power electronic switches and circuits and their applications
2 To familiarise Op amp and digital circuits and their applications
3 To acquaint with basics of microprocessor and microcontroller
4 To study structure, working and characteristics of different types of industrial electric motors and their
5 selection for a particular application

Outcomes: Learner will be able to…

1 Illustrate construction, working principles and applications of power electronic switches
2 Identify rectifiers and inverters for dc and ac motor speed control
3 Develop circuits using OPAMP and timer IC555
4 Identify digital circuits for industrial applications
5 Illustrate the knowledge of basic functioning of microcontroller
6 Analyse speed-torque characteristics of electrical machines for speed control

Module	Detailed Contents	Hrs.
01	**Semiconductor Devices:** Diodes: Principles V-I characteristics and Application of: rectifier diode, zener diode, LED, photodiode, SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn-off thyristor (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, MOSFET/IGBT Gate driver circuit Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	8
02	**Phase controlled rectifiers and Bridge inverters**: Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Derivation of output voltage Block diagram of closed loop speed control of DC motors, Necessity of inner current control loop 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)	7
03	**Operational amplifiers and 555 Timer:** Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, Optical Isolation amplifier; 555 timer-Operating modes: monostable, astablemultivibrator	4
04	**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, Propagation Delay, TTL logic family CMOS Logic family, comparison with TTL family Flip flops: Set Reset(SR),Trigger(T), clocked F/Fs; Registers, decoders and encoders, Multiplexer and Demultiplexer, applications	4
05	**Microprocessor and Microcontrollers:** Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller	8

	MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	
06	**Motors:** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor Basics of BLDC motor, Linear Actuator motor, Servo Motor Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	5

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

Reference Books:
1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics,VedamSubramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Modern Digitals Electronic, Jain R P, Tata McGraw Hill, 1984
7. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
8. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
9. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

Course Code	Course Name	Credits
AEC404	**Production Process II***	**04**

Objectives
1. To study sheet metal forming as well as mechanical behavior of stress system in metal forming processes.
2. To Acquaint tobasic principles of design of jigs and fixtures
3. To give exposure to Non-traditional machining operations.
4. To acquaint with fundamentals of metal cutting and tool engineering

Outcome: Learner will be able to:
1. Demonstrate understanding of metal cutting principles and mechanism
2. Identify cutting tool geometry of single point and multipoint cutting tool
3. Demonstrate various concepts of sheet metal forming operations
4. Demonstrate concepts and use of jigs and fixtures
5. Illustrate various non-traditional machining techniques
6. Illustrate concepts and applications of additive manufacturing

Module	Details	Hrs
1	**Metal Cutting:** 1.1 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, effect of various parameters on cutting forces 1.2 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, factors affecting surface finish	**16**
2.	**Tool Engineering**: 2.1 Cutting Tool geometry and definition of principles tool angles of single point cutting tools, Types of milling cutters and their geometry, Geometry of drill, broach 2.2 Specification & Selection of grinding wheel, dressing & truing and balancing of grinding wheels	**06**
3.	**Sheet Metal Forming**: 3.1 Sheet metal operations, Classification of presses, Types of Dies:, compound, combination, progressive, bending, forming and drawing dies, scrap strip layout, centre of pressure, selection of die sets, stock guides, strippers	**06**
4.	**Jigs and Fixtures**: 4.1 Elements of Jigs and fixtures, principles of location, types of locating and clamping elements, Drill bushes-their types and applications indexing devices, auxiliary elements, Types of jigs, Milling fixture and turning fixture	**06**
5.	**Non-traditional Machining:** 5.1 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)	**06**

		Additive Manufacturing:	
6.		6.1 Historical Development , Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping ,Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, Why use the term Additive Manufacturing, The Benefits of AM, Distinction Between AM and CNC Machining, Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD, Classifications of AM / RP System: Liquid polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems 6.2 New AM Classification Schemes as per ASTM F42 and ISO TC 261: Vat photo polymerization, Powder bed fusion, Material extrusion, Material jetting, Binder jetting, Sheet lamination and Directed energy deposition 6.3 Vat Photo Polymerization based AM / RP Systems: Principle of operation, Process, materials advantages, disadvantages, and applications of 3D Systems' stereo lithography (SLA), CMET'S Solid Object Ultraviolet-Laser Printer (SOUP).	**08**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References

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. Manufacturing science by Ghosh and Mallick
9. Production Engg By P.C.Sharma
10. Ian Gibson, D.W. Rosen, and B. Stucker, *Additive Manufacturing Technologies*, 2nd Edition, Springer 2015

Course Code	Course Name	Credits
AEC405	**Kinematics of Machinery***	**04**

Objectives:
1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To familiarise with various basic mechanisms and inversions
3. To study basics of power transmission

Outcomes: Learner will be able to:
1. Define various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Draw Cam profile for the specific follower motion
5. Analyse forces in various gears
6. Select appropriate power transmission for specific application

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'Alembert's 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:** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	10
2	**2.1 Special Mechanisms:** **Straight line generating mechanisms:** Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's, Grasshopper mechanism, Tchebicheff's mechanisms **Offset slider crank mechanisms** - Pantograph, Hook-joint (single and double). **Steering Gear Mechanism** - Ackerman, Davis steering gears	06
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 extended to find rubbing velocities at joints, mechanical advantage (Graphical approach) Velocity analysis of low degree complexity mechanism (Graphical approach), Auxiliary point method **3.2 Velocity and Acceleration Analysis of Mechanism:** Velocity and Acceleration- analysis by relative method (mechanism up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach)	10
4	**4.1 Cam Mechanism:** Cam and its Classification, Followers and its Classification, 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), Motion analysis of simple cams - R-R cam, D-R-R and D-R-D-R Cam operating radial translating follower, Pressure angle	06

5	**5.1 Belts, Chains and Brakes**: **Belts**: Introduction, types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission **Chains:** types of chains, chordal action, variation in velocity ratio, length of chain **Brakes:**Introduction, types and working principles, Introduction to braking of vehicles		06
6	**6.1 Gears and Gear Trains:** **Gears**- Introduction, types, Law of gearing, Construction of Involute and Cycloid gear tooth profile, Details of gear terminology, involutes and cycloidal tooth profile, Interference in involutes gears, Critical numbers of teeth for interference free motion Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel **Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination		10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover 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 any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. Theory of Mechanisms and Machines by Amitabh Ghosh and A. Kumar Mallik
2. Theory of Machines and Mechanism by John Uiker, Garden Pennock&Lat J.F. Shigley
3. Theory of Machines by PLBallaney
4. Theory of Machines by SSRatan
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
9. Theory of Machines by W.G.Green, Bluckie& Sons Ltd

Course Code	Course Name	Credits
AEL401	**Data Base and Information Retrieval***	**02**

Objective:

1. To acquaint with data modelling/database design using the entity-relationship
2. To study use of Structured Query Language (SQL) and learn SQL syntax
3. To familiarise Graphical User Interface techniques to retrieve information from database
4. To study needs of database processing and controlling the consequences of concurrent data access

Outcome: Learner will be able to …

1. Identify data models and schemes in DBMS
2. Demonstrate the features of database management systems and Relational database
3. Use SQL- the standard language of relational databases
4. Demonstrate understanding of functional dependencies and design of the database
5. Design graphical user Interface for specific application
6. Create visual software entities

Module	Detailed Contents	Hrs.
01	**Introduction to Database Concept:** What is a database?, Characteristics of database, 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 systems architecture, Database administrator	02
02	**Entity-Relationship Data Model:** Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model	04
03	**Rational Model and Algebra:** Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus	04
04	**Structured Query Language (SQL):** Overview of SQL, Data definition commands, set operations, aggregate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries	04
05	**Introduction to Transactions Management and Co-currency:** Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, **Co-currency Control:** Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging	04
06	**Graphical User Interface:** Murphy's law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour 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, usinf and creating ActiveX components, dynamics 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

Assessment:

Term Work:

Assign minimum two case studies for each student. On their case studies following exercises to be performed

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 Term work Marks

Laboratory work	40 Marks
Attendance	10 Marks

End Semester Practical/Oral Examination:

1. Practical examination of 2 hours duration followed by Oral to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks

Practical examination:	40 marks
Oral based on practical examination	10marks

4. Students work along with evaluation report to be preserved till the next examination

Reference Books:

1. Database Management Systems, G K Gupta, McGraw – Hill
2. Database System Concepts, Korth, Slberchatz, Sudarshan, 6thEdition, McGraw – Hill
3. GUI Design for dummies, IDG books
4. Visual Basic 2005, How to program,DeitelandDeitel,3rdEdition, Pearson Education
5. SQL and PL/SQL for Oracle 10g,Black Book, Dr PS Deshpande, Dreamtech Press
6. Introduction to Database Management,Mark L Gillenson, PaulrajPonniah, Wiley
7. Oracle for Professional,SharamanShah, SPD.
8. Database Management Systems,Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System,Mark L Gillenson, Wiley India

Course Code	Course Name	Credits
AEL402	**Fluid Mechanics***	**1**

Objectives:
1. To study measurement as well as calibration principles
2. To practically verify the concepts learnt in theory course

Outcomes: Learner will be able to ….
1. Calibrate different gauges
2. Measure hydrostatic forces
3. Verify the Archimedes Principle
4. Calibrate Venturimeter, Orificemeter and Pitot tube.
5. Verify the Bernoulli's Principle
6. Read manometers and maintain them.

(a) List of Experiments: Any 6 experiments to be performed.

Expt no	Experiment	Hrs
1	Calibration of Pressure Gauges	2
2	Measurement of Hydrostatic Pressures	2
3	Verification of Archimedes' Principle	2
4	Calibration of Venturimeter/ Orificemeter/Nozzlemeter/ Pitot tube	2
5	Determine the friction factor for Pipes	2
6	Determination of major and minor losses in Pipe systems	2
7	Verification of Bernoulli's Equation	2
8	Experiment on Laminar flow in pipes	2
9	Calculation of Lift and Drag over an aerofoil	2
10	Determine the pressure profile over an aerofoil	2

(b) Mini Project: A mini project along with a brief report in which a group of students (maximum 4) will design/ fabricate/ assemble a unit or software based simulation to demonstrate any principle in Fluid Mechanics.

Assessment:
Term work Mark distribution will be as follows:

Laboratory work	15 marks
Mini Project	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/oral based on contents. Distribution of marks for practical/Oral examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

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

Course Code	Course Name	Credits
AEL403	**Industrial Electronics***	**01**

Objectives
1. To study operational characteristics of various electrical and electronics components
2. To study microcontroller based applications and its programming

Outcomes: Learner will be able to…
1. Demonstrate characteristics of various electrical and electronics components
2. Develop simple applications built around these components
3. Identify use of different basic gates
4. Identify and use digital circuits for industrial applications
5. Built and demonstrate basic parameter measurement using microcontroller
6. Test and Analyse speed-torque characteristics of electrical machines for speed control.

List of Experiment: Minimum six from 1-9 and four from 10-15, in all minimum ten experiments need to be performed

SrNo	Detailed Contents	Hrs.
1	MOSFET / IGBT as a switch	
2	V-I characteristics of SCR	
3	Triggering circuit of SCR (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	Speed control of DC motor	
12	Speed control of induction motor	
13	Simple programs using microcontroller	
14	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive	
15	Microcontroller based speed control for Induction Motor	

Learners (in a group) may be encouraged for Project Based Learning. Appropriate weightage may be given in term work assessment

Assessment:

Distribution of marks for term work
Laboratory work   20 Marks
Attendance   05 Marks

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/Oral based on contents
2. Distribution of marks for practical/Oral examination shall be as follows:
   Practical performance   15 marks
   Oral   10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEL 404	Kinematics of Machinery*	01

Objectives:
1. To familiarise with various mechanisms and inversions
2. To acquaint with basics of power transmission systems

Outcomes: Learner will be able to…
1. Draw velocity diagram by instantaneouscentre method
2. Draw velocity and acceleration diagrams for four bar mechanism by relative method.
3. Draw velocity and acceleration diagrams for Slider crank mechanism by relative method
4. Draw Cam profile for the specific follower motion
5. Plot displacement-time, velocity-time, acceleration-time cam profiles
6. Develop and build mechanisms to provide specific motion

Term Work:(Comprises a & b)

a) **List of Experiments**

Sr No	Details	Lab Session
1	Analysis of velocity of mechanisms by Instantaneous Center of Rotation – 3 to 5 problems	2 Hrs
2	Analysis of velocity of mechanism by Relative method – 3 to 5 problems	4 Hrs
3	Analysis of Velocity & Acceleration of mechanism by Relative method – 3 to 5 problems	4 Hrs
4	Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time and layout of cam profiles - 2 to 3 problems	4 Hrs
5	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students	6 Hrs

b) **Assignments:** Minimum two problems on each of the following topics:
  i) Brakes
  ii) Chains and belts
  iii) Gear and gear trains

Distribution of marks for Term Work shall be as follows:
  Laboratory work : 15marks.
  Assignments : 05 Marks
  Attendance : 05 marks.

Course Code	Course Name	Credits
AEL405	**Machine Shop Practice – II***	**2**

Objectives:

1. To familiarise with basic machining processes.

2. To Acquaint to various machining operations and machine protocols

Outcomes: Learner should be able to ….

1. Operate lathe machine,
2. Perform shaping operations
3. Perform finishing operations on grinding machine
4. Perform milling operations.
5. Perform precision turning
6. Perform drilling and threading operations.

Module	Details	Hrs
1	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**

Term Work:

1. Composite job mentioned above

2. Complete Work-Shop Book giving 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 ……. 10 marks

Practical Examination:

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

Course Code	Course Name	Credits
AEC501	**Internal Combustion Engines***	**4**

Objectives
1. To familiarize with the working of S.I. and C.I. engines and its important systems
2. To acquaint with the various methods for measurement of engine performance
3. To provide insight into the harmful effects of engine pollutants and its control
4. To familiarise with the latest technological developments in engine technology

Outcomes: Learner will be able to…

1. Demonstrate the working of different systems and processes of S.I. engines
2. Demonstrate the working of different systems and processes of C.I. engines
3. Illustrate the working of lubrication, cooling and supercharging systems.
4. Analyse engine performance
5. Illustrate emission norms and emission control
6. Comprehend the different technological advances in engines and alternate fuels

Module	Detailed Contents	Hrs.
01	**Introduction** Classification of I.C. Engines; Parts of I.C. Engine and their materials, Cycle of operation in Four stroke and Two-stroke IC engines and their comparative study; Fuel air cycles and their analysis, Actual working cycle, Valve Timing Diagram. LHR Engines, Homogeneous charge compression Ignition,Rotary engine-Six stroke engine concept	06
02	**S.I. Engines** **Fuel Supply System:** Spark ignition Engine mixture requirements, Fuel-Air ratio, Simple carburettor and auxiliary circuits (excluding mathematical analysis of carburettors) Injection systems: Single-point and Multipoint injection, Gasoline Direct Injection **Ignition System:** Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker **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** **Fuel Injection Systems:** Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzle, Electronically controlled unit fuel injection system **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	10
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, Limitations, Methods and Types,Different arrangements of turbochargers and superchargers	06

05	**Engine Testing and Performance** Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engine Effect of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric efficiencies, Heat balance sheet. **Engine Exhaust Emission and its control** Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms.	10
06	**Alternative Fuels** Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **Basics of Electronic Engine Controls:** Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	04

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover 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 any module other than module 3)
4. Only **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 , TMH
7. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
8. Internal Combustion Engine, V Ganesan, TMH
9. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4th Edition
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 Name	Credits
AEC502	**Mechanical Measurement and Control***	4

Objectives

1. To impart knowledge of architecture of the measurement system
2. To deliver working principle of mechanical measurement system
3. To study concept of mathematical modelling of the control system
4. To acquaint with control system under different time domain

Outcomes: Learner will be able to…

1. Classify various types of static characteristics and types of errors occurring in the system.
2. Classify and select proper measuring instrument for linear and angular displacement
3. Classify and select proper measuring instrument for pressure and temperature measurement
4. Design mathematical model of system/process for standard input responses
5. Analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability

Module	Contents	Hours
01	1.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. 1.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. 1.3 Errors in measurement: Types of errors, Effect of component errors, Probable errors.	**08**
02	2.1 **Displacement Measurement**: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder) , Nozzle Flapper Transducer 2.2 **Strain Measurement**: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors 2.3 **Measurement of Angular Velocity**: Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods. 2.4 **Acceleration Measurement:** theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers	**08**
03	3.1 **Pressure Measurement:** Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges 3.2 **Flow Measurement**: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter 3.3 **Temperature Measurement**: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers 3.4 **Sensitivity analysis of sensor**-influence of component variation 3.5 **Signal conditioning**: Amplifier, Conversion, Filtering, Impedance Buffering, Modulation / Demodulation, Linearization, Grounding and Isolation	**08**
04	**4.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems. **4.2** Mathematical modelling of control systems, concept of transfer function, Block diagram algebra	**06**

05	**5.1 Transient and steady state analysis of first and second order system.** Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	**06**
06	**Stability analysis** 6.1 Introduction to concepts of stability, The Routh criteria for stability 6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot and Nyquist Plots 6.3 State space modeling 6.4 Process control systems, ON-OFF control. P-I-D Control	**12**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover 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 any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition,*McGraw Hill*
2. Mechanical Engineering Measurements, A K Sawhney, *Dhanpat Rai& Sons, New Delhi*
3. Instrumentation & Mechanical Measurements, A KThayal
4. Control System Engineering by NagrathIJ and Gopal M, *Wiley EasternLtd.*
5. Modem Control engineering: by KOgata, *Prentice Hall*
6. Control systems by DhaneshManik, Cengage Learning
7. Engineering Metrology and Measurementsby N V Raghavendra and L Krishnamurthy, Oxford University Press
8. Instrumentation and Control System, W. Bolton, Elsevier
9. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
10. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
11. Mechanical Measurements by S P Venkateshan, Ane books, India

Course Code	Course Name	Credits
AEC 503	**Heat Transfer***	**04**

Objectives
1. To Study basic heat transfer concepts applicable for steady state and transient conditions
2. To Study mathematical modelling and designing concepts of heat exchangers

Outcomes: Learner will be able to…
1. Identify the three modes of heat transfer (conduction, convection and radiation).
2. Illustrate basic modes of heat transfer
3. Develop mathematical model for each mode of heat transfer
4. Develop mathematical model for transient heat transfer
5. Demonstrate and explain mechanism of boiling and condensation
6. Analyse different heat exchangers and quantify their performance

Module	Detailed Contents	Hrs.
01	**Basic concepts of heat transfer:**Define heat transfer and its importance in engineering applications, Difference between heat transfer and Thermodynamics, Physical Mechanism of modes of heat transfer, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body, Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat transfer, Thermal contact resistance	04
02	**Conduction:**Assumptions in heat conduction, Generalized heat conduction equation in rectangular, cylindrical coordinates, Initial and boundary conditions, Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, Internal Heat generation concept, Heat conduction with heat generation in plane wall, solid cylinder and solid sphere, Critical radius of insulation in cylinder and sphere	08
03	**Heat transfer from Extended Surface:**Types of extended surface and its significance, Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermo Well **Unsteady state heat transfer:**Applications of unsteady state heat transfer, Lumped system Analysis, Criteria for lumped system analysis: characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts **Numerical methods in heat transfer:**Significance of numerical methods in heat transfer, Finite difference formulation of differential equations, One-dimensional heat conduction.	08
04	**Convection:**Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance **External Flow:**Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes **Internal Flow:**Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes, General thermal analysis: Constant heat flux and constant surface temperature	10
05	**Radiation:**Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	08
06	**Boiling and Condensation:**Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation **Heat Exchangers:**Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor, Effectiveness of heat exchangers **Heat Pipe:** Introduction and application	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover 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 any module other than module 3)
4. Only **Four questions need to be solved**

ReferenceBooks:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel2ndEdition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by FPIncropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and LMalaysamy,2ndEdition, PEARSON
5. Heat Transfer by J P Holman, Mcgraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer byR K Rajput, S Chand and company

Course Code	Course Name	Credits
AEC 504	**Automotive Systems**	**3**

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. Identify different automotive systems and subsystems.
2. Identify different automotive components.
3. Illustrate working and functions of various automotive components
4. Illustrate working and function of electric drive lines.
5. Comprehend working of Special vehicles through case study.
6. Identify and Demonstrate different vehicle layouts.

Module	Detailed Contents	Hrs.
01	**1. CLUTCHES** 1.1 Function requirements of Flywheel and clutch 1.2 Types of Single plate clutch 1.4 Clutch control systems 1.5 Clutch center plate construction 1.6 Direct release clutch 1.7 Centrifugally operated clutches 1.8 Multi-plate clutches 1.9 Angle spring clutch 1.10 Wet clutch 1.11 Fluid Coupling	08
02	**2.TRANSMISSION** 2.1 Purpose and Necessity 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 Torque convertors** **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 lay shaft 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

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03	**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	04
04	**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	04
05	**5. BRAKING AND SUSPENSION SYSTEMS** 5.1 Braking System 5.1.1 Requirement and Types-Block Brakes, Band Brakes, Hydraulic brake, Air Brake, Endurance Brake 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	06
06	**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 Tires, Road wheels and Hubs 6.2.1 Introduction to Tire characteristics 6.2.2 Tire construction 6.2.3 Road wheels and hubs	06

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

    i)   Question paper will comprise of total six questions.

    ii)   All questions carry equal marks.

    iii) Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

    iv) Only four questions need to be solved.

ReferenceBooks:

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 Name	Credits
AEDLO5011	**Press Tool Design***	**4**

Objectives:
1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to….
1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. Elaborate failure mechanisms of pressed components, safety aspects and automation in press working

Module	Contents	Hours
1	**Introduction to Press Working** – 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Construction of Basic shearing die. Functions of different elements of a press tool. Methods of feeding the strip/coil material.	**08**
2	**Design and Calculations** of Piercing & Blanking Die– 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, Recommending minimum tonnage of a press. Centre of Pressure (its importance and calculation) 2.2 Design aspects of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools 2.3 Different types Die sets and its selection	**14**
3	3.1 **Selection of Material & Hardware** –Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools.	**03**
4	**Bending and Drawing-** 1.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies 1.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup 1.3 Defects in drawn as well as bent parts, Presses selection for drawing/forming operations 1.4 Basic construction and working of Bending and Drawing dies	**12**
5	5.1 **Miscellaneous Dies-** Basic construction & working of Shaving dies, Trimming dies,Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies	**05**
6	**Selection of Presses and its setting** – 6.1 Selection of Press and Press setting for Shearing, Bending, Progressive and Drawing dies, Equipment for Sheet metal operations (Basics only), Overloading of presses (load, energy considerations) 6.2 Introduction to Automation & Safety in Press shop	**06**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Earyand E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Course Code	Course Name	Credits
AEDLO5012	**Machining Sciences And Tool Design***	4

Objectives
1. To familiarise with the basic concepts of machining science like mechanics of machining, tool wear, tool life and surface roughness.
2. To familiarise with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to:
1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyse heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyse economics of machining operations

Module	Details	Hrs.
01	1.1 **Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model& modified model for orthogonal cutting, Lee and Shaffer model, Analytical modelling of machining operations, mechanistic modelling of machining, slip line field analysis, finite element analysis, modelling of material properties 1.2 **Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry	10
02	2.1 **Temperatures in metal cutting and cutting fluids:** Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, temperature in primary deformation zone, temperature in secondary deformation zone, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work-tool thermocouple, direct thermocouple measurement, radiation methods, hardness and microstructure changes in steel tools Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, cutting fluid maintenance and environmental considerations, disposal of cutting fluids, dry cutting and minimum quantity lubrication, cryogenic cooling	06
03	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	06

	geometrical contribution to roughness, edge finishing, residual stress and micro hardness	
04	4.1 **Tool life and machining economics:** Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, Experimental methods to find Taylor exponents, Components of product cost,Optimum cutting velocity for minimum cost of production and maximum production rate	**06**
05	5.1 **Design of single point cutting tools** : Different systems of tool nomenclature like MRS, ORS and NRS, Interrelationship among different systems of nomenclature for tool angles, Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders	**08**
06	6.1 **Design of multi point cutting tools :** Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application, Profile design of flat and circular form tools,Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters	**10**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References
1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow

Course Code	Course Name	Credits
AEDLO5013	**Design of Jigs and Fixtures***	**4**

Objectives

1. To acquaint with the concepts of planning and writing sequence of operations
2. To acquaint basics of identification and selection of location and clamping points on work-piece
3. To familiarise design principles in designing simple productive and cost effective jigs and fixtures

Outcomes: Learner will be able to…

1. Write methodically, thesequence of operations of simple work-piece
2. Identify and select locating and clamping points on work-piece
3. Demonstrate construction of drill jig
4. Illustrate construction of milling fixture
5. Identify appropriate combination of tools, jigs and fixture, suitable for a particular machining operation
6. Design assembly of jigs and fixtures on simple work-piece

Module	Details	Hrs
01	1.1 **Introduction to Tool Design** Production Tooling's Jigs, Fixtures and their difference, their requirement(accuracy, machinability, quantity modifications so as toassist production, Interchange ability, Simplicity, Swarf disposal,Handling, Ease of operation, Skill reduction, Cost reduction), Analysis forOperation planning, sequencing of operations.	**08**
02	**Basic Construction of Jig & Fixture** 1.1 **Location & Locating Devices** Locating principles: Degrees of freedom, Redundant location, Fool-proofing, nesting, Locators: locators that control work piece on flat surfaces, location of cylindrical surfaces, conical locators, centralizers. 1.2 **Clamping & clamping Devices** Requirement of clamping system, Position of clamps, Types of clamps, Clamping devices; examples of typical clamps(multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices), Component distortion under clamping and cutting forces, Material used for different clamping devices of jigs/fixture and recommended hardness	**10**
03	3.1 **Construction of Drill Jig** Introduction, Selection of location, supporting and clamping faces /points, cutting tools and means of guiding and supporting Jigs, varioustypes of Jig Bushes, Commonly used drill jigs, Case Study on Design of Drill Jig	**10**
04	4.1 **Construction of Milling fixture** Introduction, Selection of location, supporting and clamping faces /points choice, tool setting block and Tennon's, Case Study on Design of Milling Fixture	**08**
05	5.1 **Introduction to Commonly used Fixtures** Turning Fixture (Chucks, collets, Mandrels) Grinding Fixture, BroachingFixture, and Welding Fixture	**08**
06	6.1 **Indexing Jig & Fixture** Introduction, Application of indexing, Essential features of an indexing jig /fixture, Indexing Devices	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**

References
1. Jig and Fixture Design Manual, Erik K. Henrikson, Industrial Press
2. An introduction to jig and tool Design, MH A Kempster, 3rd Edition, ELBS
3. Jigs and Fixture, P. H. Joshi, TMH
4. Tool design, C. Donaldson, George H. Lecain, V.C. Goold, TMH
5. Jigs and Fixture Handbook, A.K. Goroshkin, Mir Publication
6. Jigs and Fixture, ASTME
7. Non- Standards Calming Devices, Hiran E. Grant TMH, New Delhi

Course Code	Course Name	Credits
AEL 501	**Internal Combustion Engines Lab***	**01**

Objectives:
1. To familiarise concept of thermal conductivity, heat transfer coefficient through experiments
2. To familiarise experimental verification of the concepts of heat transfer

Outcomes: Learner will be able to ….
1. Dismantle engine assembly
2. Overhaul and Assemble engine components
3. Perform load test/speed test on engine setup
4. Calculate performance of multi cylinder engine
5. Analyse engine performanceand draw heat balance sheet
6. Perform exhaust gas analysis

Part A: Dismantle, overhaul and assemble the following
1. 2 Stroke/ 4 Stroke Engines
2. Carburettor
3. Ignition system
4. Fuel injection system

Part B: Performing experiments on engine test rigs
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 and volumetric efficiency of the engine
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 exercises, from the list, out of which minimum 4 must be actual experiments from Part B 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:
1. Laboratory work (Exercises) :   **15 marks**
2. Case study: **05 marks**
3. Attendance: **05 marks**

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/Oral based on contents
2. Distribution of marks for practical/Oral examination shall be as follows:
   Practical performance   15 marks
   Oral   10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course/Subject Name	Credits
AEL 502	Mechanical Measurement and Control*	1

Objectives
1. To study calibration of different measuring instruments
2. To study working of mechanical measurement system
3. To familiarise with different types of control systems

Outcomes: Learner will be able to…
1. Calibrate displacement sensors
2. Calibrate pressure and vacuum gauges
3. Measure torque using strain gauges
4. Identify system/process characteristics for standard input responses
5. Identify various types of control systems and time domain specifications
6. Analyse the problems associated with stability

List of Experiments

Sr. No.	Topic
1	Calibration of Displacement sensors like LVDT, Potentiometers etc.
2	Calibration of Pressure Gauges
3	Calibration of Vacuum Gauges
4	Torque measurement using strain gauges
5	Calibration of tachometers
6	Vibration Measurement & Calibration of Accelerometers.
7	Experiments on feedback control systems and servomechanisms
8	System Identification of any one of the sensor
9	Experiment on frequency response system identification
10	Experiment on transient state response of a control system.
11	Experiment on design of PID controller for a system.

(a) Design based experiments shall be encouraged using standard National Instrument/ texas instrument/ dSPACEGmbh/ Arduino or any other platform),**Learners (in a group) may be encouraged for Project Based Learning. Appropriate weightage may be given in term work assessment**

Term Work

Term work shall consist of minimum 8experiments (04 from the measurement group and 4 from the control group),
The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) **:** **15 marks**
- Design based experiment: **05 marks**
- Attendance**:** **05 marks**

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/Oral based on contents
2. Distribution of marks for practical/Oral examination shall be as follows:

   Practical performance   15 marks
   Oral   10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
AEL 503	**Heat Transfer Lab***	**01**

Objectives:
1. To familiarise concept of thermal conductivity, heat transfer coefficient through experiments
2. To familiarise experimental verification of the concepts of heat transfer

Outcomes: Learner will be able to ….
1. Estimate thermal conductivity of metals/non metals/liquids
2. Compute heat transfer coefficient in natural as well forced convection
3. Measure emissivity of grey body
4. Quantify fin effectiveness/efficiency
5. Analyse heat exchanger performance
6. Demonstrate energy balance for heat exchanger

The laboratory experiments should be based on the following:

Exp.No	Name of Experiments	Time
1	**Conduction: (Any Two)** 1. Measurement of thermal conductivity of metal rod 2. Measurement of thermal conductivity of insulating material 3. Measurement of thermal conductivity of liquid 4. Determination of contact resistance 5. Effect of area on heat transfer	2Hrs
2	**Convection: (Any One)** 1. Measurement of heat transfer coefficient in natural convection 2. Measurement of heat transfer coefficient in forced convection 3. Comparison of heat transfer coefficient of free and forced convection	2Hrs
3	**Radiation: (Any One)** 1. Verification of Stefan Boltzmann Law 2. Measurement of Emissivity of Grey surface	2Hrs
4	**Transient Conduction:** 1. Unsteady state heat transfer in cylinder/rod/wall	2Hrs
5	**Fins: (Any One)** 1. Determination of fin efficiency and fin effectiveness 2. Comparison of fin performance of Various type of fins	2Hrs
6.	**Boiling and Condensation: (Any One)** 1. Measurement of heat transfer coefficient in boiling process of water. 2. Measurement of heat transfer coefficient in condensation of saturated steam.	2Hrs
7	**Heat Exchangers: (Any One)** 1. Estimation of overall heat transfer coefficient and effectivenessof double pipe heat exchanger (parallel flow and Counter flow arrangement) 2. Estimation of overall heat transfer coefficient and effectivenessof shell and tube heat exchanger (parallel flow and Counter flow arrangement) 3. Estimation of overall heat transfer coefficient and effectiveness of plate type heat exchanger.	2Hrs

Assignments: Assignment consisting of at least 3 numerical on each of the following topics

1. Steady state conduction
2. Fins and unsteady state conduction
3. Convection and dimensional analysis

4. Radiation
5. Heat Exchangers

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments.**

<u>**Assessment:**</u>
Term work Mark distribution will be as follows:

Laboratory work	15 marks
Assignments	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/Oral based on contents Distribution of marks for practical/Oral examination shall be as follows:

Practical performance	15 marks
Oral	10 marks

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

Course Code	Course Name	Credits
AEL504	**Automotive Systems**	**1**

Objectives:

1. To help student better understand Automotive systems and subsystems through cut section models and Case studies
2. To give hands on experience to students on different automotive systems through Dismantling and Assembly
3. To Understand latest developments in automotive systems technology.

Outcomes: Learner will be able to
1. Identify Automobile systems and subsystems.
2. Dismantle and assemble Clutch
3. Dismantle and assemble Gearbox
4. Dismantle and assemble Propeller shaft
5. Dismantle and assemble Steering Gearbox
6. Dismantle and assemble Differential

Term Work :(Comprises both A & B)

A.List of Experiments
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 any one type of braking systems.

B.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, Bijli 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.

The distribution of marks for term work shall be as follows:
1) Part A: **10 marks**
2) Part B: **10 marks**
3) 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.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/Oral based on contents Distribution of marks for practical/Oral examination shall be as follows:

   Practical performance   15 marks

   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

Students work along with evaluation report to be preserved till the next examination

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Course Code	Course Name	Credits
AEL 505	**Manufacturing Sciences Lab***	**1**

Objectives:
1. To study conventional machining operations
2. To familiarise with CNC machining operation
3. To acquaint with Non Traditional machining operations

Outcomes: Learner will be able to …
1. Estimate machining time forsimple and taper turning operations on lathe
2. Estimate machining time for threading/knurling operations on lathe
3. Estimate machining time for various machining operations on shaper
4. Perform NC, CNC and DNC machining operations
5. Write CNC program for different operations
6. Identify machining parameters for various Non Traditional machining operations

Sr No.	Details
1	Introduction to machining operations
2	Introduction to lathe machine (other than plain turning operation) and shaping machine
3	Machining and machining time estimation for taper turning
4	Machining and machining time estimation for thread cutting
5	Machining and machining time estimation for internal thread cutting
6	Machining and machining time estimation for knurling
7	Machining and machining time estimation for eccentric turning
8	Machining of hexagon and square in shaping machine
9	NC, CNC, DNC machining operations
10	CNC programming for Turning and Drilling operations
11	Different Non Traditional machining operations with process parameters

Term Work:

All the assignments mentioned above with relevant sketches.

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

        All the above listed assignments: **20 marks**

        Attendance: **05 marks**

Subject Code	Subject Name	Credits
MEL506	**Business Communication & Ethics**	**02**

Objectives:
1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

Outcomes: Learner will be able to…
1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Module	Detailed Contents	Hrs.
01	**Report Writing**	**05**
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility)and Formats of reports (Memo, Letter, Short and Long Report)	
02	**Technical Writing**	**03**
2.1	Technical Paper Writing (IEEE Format)	
2.2	Proposal Writing	
03	**Introduction to Interpersonal Skills**	**09**
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	**Meetings and Documentation**	**02**
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	**Introduction to Corporate Ethics**	**02**
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
06	**Employment Skills**	**07**
6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	

6.4	Presentation Skills	
6.5	Statement of Purpose	

Assessment:

List of Assignments

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list.

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

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

References:

1. Fred Luthans, "Organizational Behavior", Mc Graw Hill,
2. Lesiker and Petit, "Report Writing for Business*"*, Mc Graw Hill
3. R.Subramaniam, "Professional Ethics" Oxford University Press
4. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
6. Hill Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th Edition
7. Heta Murphy, "*Effective Business Communication"* , Mc Graw Hill, edition
8. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing",*
9. Raman Sharma, *Communication Skills*, Oxford University Press
10. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill Lehman,
11. Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
12. Bell . Smith, "Management Communication" Wiley India Edition, 3rd edition
13. Dr. K. Alex ,"Soft Skills", S Chand and Company
14. Robbins Stephens P., "Organizational Behavior", Pearson Education
15. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Course Code	Course Name	Credits
AEC 601	**Chassis and Body Engineering**	**4**

Objectives

1. To Understand fundamentals of Vehicle Body design
2. To Study different vehicle structural design and their requirements.
3. To Study Vehicle Aerodynamics.
4. To Study different vehicle body structures
5. To study various materials related to body structures

Outcomes: Learner will be able to…

1. Illustrate different types of Vehicle structures
2. Comprehend various loads acting on vehicle body.
3. Illustrate different vehicle body styles.
4. Classify different materials related to vehicle body.
5. Discuss Aerodynamic concept related to vehicle body
6. Illustrate importance of thin walled structures in vehicle body elements.

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: Introduction to 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)	08
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. **2.3 Commercial 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.	08
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.	08

04	**Ergonomics and Preliminary Design** **4.1 Design and requirement of Driver, Passenger and child seat.** 4.2 Drawing of the preliminary design-Vehicle Body Weight Analysis, Calculation of C.G for Vehicle, Vehicle Weight Distribution and Master Model. 4.3 Overall Criteria for Vehicle Comparison: Design, Running costs, Overall Design Efficiency.	08
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.	08
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	08

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.
iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

ReferenceBooks:

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 Name	Credits
AEC602	**MACHINE DESIGN – I***	**4**

Objective:

1. To study basic principles of machine design
2. To acquaint with the concepts of design based on strength & rigidity
3. To familiarize with use of design data books & various codes of practice
4. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to ….

1. Demonstrate understanding of various design considerations
2. Illustrate basic principles of machine design
3. Design machine elements for static as well as dynamic loading
4. Design machine elements on the basis of strength/ rigidity concepts
5. Use design data books in designing various components
6. Acquire skill in preparing production drawings pertaining to various designs

Modules	Details	Hrs.
1	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers	**06**
2	**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**
3	**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**
4	**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**
5	**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 Flange couplings, Bush pin type flexible couplings	**11**
6	**Design of Springs:** Helical compression, Tension Springs under Static and Variable loads, Leaf springs	**07**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas& Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts

Course Code	Course Name	Credits
AEC603	**FINITE ELEMENT ANALYSIS***	4

Objectives:

1. To familiarise with concepts of FEM
2. To study the applicability of FEM to engineering problems
3. To acquaint with application of numerical techniques for solving problems

Outcomes: Learner will be able to.....

1. Solve differential equations using weighted residual methods
2. Develop the finite element equations to model engineering problems governed by second order differential equations
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system
6. Use commercial FEA software, to solve problems related to mechanical engineering

Module	Details	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 Modelling of field problems in engineering, Governing equations, Differential equations in different fields 1.3 Approximate solution of differential equations, Weighted residual techniques, Boundary value problems	08
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	08
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, modelling, meshing, boundary condition, convergence of solution, result analysis, case studies	10
04	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element, four node quadrilateral element, eight node quadrilateral element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular and quadrilateral element 4.3 Sub parametric, Isoparametric, super parametric elements, Compatibility, Patch test, Convergence criterion, sources of errors	08

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 nodeQuadratic element	08
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	06

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**

References:
1. Text book of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by JNReddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu,Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John-Wiley Sons
7. The Finite Element Method in Engineering by SSRao, Butter WorthHeinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Course Code	Course Name	Credits
AEC 604	Mechanical Vibrations	4

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

Outcomes: Learner should be able to ….
1. Develop mathematical model to represent dynamic system.
2. Estimate natural frequency of mechanical system.
3. Analyze vibratory response of mechanical system.
4. Estimate the parameters of vibration isolation system.
5. Balance an existing unbalanced rotating and reciprocating system completely/partially.
6. Comprehend the application of condition monitoring and fault diagnosis on a live project/case study.

Module	Details	Hrs
01	**1.1 Basic Concepts of Vibration** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper; Damper models, Vibration Terminology—periodic motion, non periodic motion, aperiodic motion, Simple harmonic motion (SHM), Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. **1.2 Free Undamped Single Degree of Freedom Vibration Systems**Longitudinal, transverse, torsional vibration systems; Formulation of differential equations by Newton's method or D'Alembert's principle; Energy, Lagrangian and Rayleigh's Methods.	08
02	**2.1 Free Damped Single Degree of Freedom Vibration Systems** Viscous damped system – underdamped, critically-damped, overdamped; Logarithmic decrement; Coulomb's damping; Combined viscous and Coulomb's damping. **2.2 Equivalent Single Degree of Freedom Vibration Systems** Conversion of multi-springs, multi masses, multi–dampers into a single spring-mass-dampersystem with linear or rotational co-ordinates.	08
03	**3.1 Free Undamped Multi Degree of Freedom Vibration Systems** Eigen values and Eigen vectors for linear and torsional systems (limited to a maximum of three degrees of freedom); Holzer method for linear and torsional unbranched systems; Two rotor system, Three rotors and geared system; Transfer function approach;Dunkerley's and Rayleigh's method for transverse vibrations	08
04	**4.1 Forced Single Degree of Freedom Vibratory Systems** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (viscous damping only) **4.2 Vibration Isolation and Transmissibility** Force Transmissibility, Motion Transmissibility, Typical isolators& mounts **4.3Vibration Measuring Instruments** Principle of seismic instruments; Vibrometer, Accelerometer, Velometer– with and without measurement errors. Principle of frequency-measuring instruments; Fullartor's tachometer and Frahm's tachometer	08
05	**5.1 Balancing of Rotating Masses** Static and dynamic balancing of multi rotor system **5.2 Balancing of reciprocating masses:** Approximate analytical method for finding acceleration of reciprocating piston (mass of connecting rod and crank neglected); Primary and secondary unbalanced forces, In-line engines, V - engines (excluding radial engines), Direct and Reverse Crank method.	08

06	**6.**1 Stability of four wheel vehicle taking a turn considering gyroscopic effect	**08**
	6.2 **Rotor Dynamics:**	
	Critical speed of a single rotor - undamped and damped.	
	6.3 Introduction to Conditioning Monitoring and Fault Diagnosis. At least two case studies in detail based on Conditioning Monitoring and Fault Diagnosis.	

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

 i.   Question paper will comprise of total six questions.
 ii.   All questions carry equal marks.
 iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
 iv.   Only four questions need to be solved.

Reference Books:
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 Name	Credits
AEDLO6021	**Mechatronics**	**4**

Objectives
1. To study key elements of Mechatronics system and its integration
2. To familiarise concepts of sensors characterization and its interfacing with microcontrollers
3. To acquaint with concepts of actuators and its interfacing with microcontrollers
4. To study continuous control logics i.e. P, PI, PD and PID
5. To study discrete control logics in PLC systems and its industrial applications

Outcomes: Learner will be able to…
1. Identify the suitable sensor and actuator for a Mechatronics system
2. Select suitable logic controls
3. Analyse continuous control logics for standard input conditions
4. Develop ladder logic programming
5. Design hydraulic/pneumatic circuits
6. Design a Mechatronics system

Module	Detailed Contents	Hrs.
1	**Introduction of Mechatronics and its block diagram representation** Key elements of mechatronics, Applications of Mechatronics domestic, industrial etc. Representation of mechatronic system in block diagram and concept of transfer function for each element of mechatronic system, Reduction methods and its numerical treatment for represented block diagram	08
2	**Selection of Sensors & Actuators** Sensors:Criteria for selection of sensors based on requirements, principle of measurement,sensing method, performance chart etc. (Displacement,temperature, acceleration,force/pressure) based on static and dynamic characteristics. Actuators: Selection of actuators based on principle of operation, performancecharacteristics, maximum loading conditions, safety etc. Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08
3	**Data Acquisition, Signal Conditioning & Microcontroller SystemTheory:** Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Convertor) Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Convertor) R-2R circuit and DAC resolution Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases	08
4	**Pneumatics and hydraulics:** Hydraulic and pneumatic devices:Different types of valves, Actuators and auxiliary elements in Pneumatics and hydraulics, their applications and use of their ISO symbols, Synthesis and design of circuits (up to 2 cylinders)–pneumatic, electro- pneumatics and hydraulics, electro-hydraulics	08
5	**Control System** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram P, I and D control actions, P, PI, PD and PID control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method	08
6	**Discrete Control System PLC (Programming Logic Control)Theory:** Introduction to PLC, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	08

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc
2. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
3. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
4. Introduction to Mechatronics and Measurement Systems, Alciatore and HistandTata McGraw-Hill
5. Mechatronics, Necsulescu, Pearson education
6. Mechatronics - Electromechanics and Control Mechanics , Mill Springer-Verlag
7. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
8. Mechatronics - Electronics in products and processes , Bradley, et al. Chapman and Hall
9. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, Prentice Hall
10. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
11. Pneumatic Circuits and Low Cost Automation by Fawcett JR
12. The Art of Electronics, Horowitz and Hill Cambridge, University Press
13. Electromechanical Design Handbook , Walsh, McGraw-Hill
14. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
15. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, Addison Wesley
16. Principles and Applications of Electrical Engineering , Rizzoni, Irwin Publishing
17. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics , KammIEEE
18. Modeling and control of Dynamic Systems, Macia and Thaler, Cengage Learning, India Edition
19. Mechatronics, A. Smaili, F. Mrad, OXFORD Higher Education.
20. Pneumatic and Hydraulic Control Systems: Aizerman. M.A.
21. Industrial Hydraulics: Pippenger
22. Vickers Manual on Hydraulics
23. Computer Numerical Control of Machine Tools: Thyer. G.R.
24. Pneumatic Applications: Deppert Warner & Stoll Kurt
25. Mechanization by Pneumatic Control: Vol. 1 & 2 Deppert Warner & Stoll kurt
26. Hydraulics and Pneumatics for Production: Stewart
27. Hydraulic Valves and Controls: Pippenger
28. Fundamentals of pneumatics: Festo series
29. Automatic Control Engineering: Francis. H. Raven.
30. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
31. Mechatronics, HMT
32. System Identification: Theory for the User (2nd Edition) , Lennart Ljung
33. Design with Microprocessors for Mechanical Engineers, StifflerMcGraw-Hill

Course Code	Course/Subject Name	Credits
AEDLO6022	**Robotics**	**04**

Objectives:
1. To study the basics of robotics and its control
2. To study various design principles of robotics through kinematic analysis, workspace analysis, and trajectory planning
3. To study applications of robots in industrial inspection and material handling
4. To study the role of a robot as a humanoid

Outcomes: Learner will be able to…
1. Demonstrate the basic functioning of a robot
2. Identify various components of robots
3. Carryout kinematic analysis, workspace analysis, and trajectory planning for a robot
4. Identify suitable sensors/actuators for robot
5. Select an appropriate robot for given industrial inspection and material handling systems.
6. Illustrate various aspects of a robot as a humanoid

Module	Details	Hrs.
01	**Introduction** Definition of robot, Evolution of robots, Laws of robots, International Robotic Standards, Types of robots, Selection of robots, Robot Classifications, Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Actuators and sensors, Drives and transmission systems, End effectors, Applications of robots	08
02	**Kinematics of Robots** **Direct:** Link coordinates D-H Representation, The ARM equation, Direct kinematic analysis for Four axis, SCARA Robot and three, five, and six axis Articulated Robots. **Inverse:** The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot. **Mobile Robot Kinematics** Introduction, Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Mobile robot maneuverability, Degree of mobility, Degree of steerability, Mobile robot workspace, Degree of freedom, Holonomic robots, Path and trajectory considerations, Motion control, Open loop control, Feedback control.	10
03	**Workspace Analysis and Trajectory Planning** Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - Continuous path motion, Interpolated motion, Straight line motion and Cartesian space technique in trajectory planning.	10
04	**Sensors & Actuators** Sensors: Selection of sensors (Displacement, temperature, acceleration ,force/pressure) based on static and dynamic charecterstics, Interfacing: Concept of interfacing, bit accuracy and sampling speed, amplifying electronics, and microcontroller Actuators: Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08

05	**Robots for Inspection and Material Handling**	08
	Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations	
	Concepts of material handling, Principles and considerations in material handling systems design, Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles, Conveyor systems, Cranes and Hoists, Advanced material handling systems, Automated guided vehicle systems, Automated storage and retrieval systems, Bar code technology, Radio frequency identification technology	
06	**Humanoids**	08
	Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, and sound, Vision, Tactile Sensing, Models of emotion and motivation, Performance, Interaction, Safety and robustness, Applications, Case studies	

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**

References

1. Yoram Korean, "Robotics for engineers", McGrew Hill Co.
2. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
3. Robotics: Fundamental Concepts and Analysis by AshitavaGhosal, Oxford University Press
4. R.K. Mittal and I.J. Nagrath, "Robotics and Control", TMH Publications
5. Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning
6. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robtics and Automation Sensor – Based integration, Academic Press
7. K.S.Fu, R.C.Gonzalex, and C.S.G.Lee, "Robotics Control Sensing, Vision and Intelligence", McGrew hill Book co.
8. Hartenberg and Denavit, "Kinematics and Synthesis of linkages", McGrew Hill Book Co.
9. A.S. Hall, "Kinematics and Linkage Design", Prentice Hall
10. J.Hirchhorn, "Kinematics and Dynamics of Machinery", McGrew Hill Book Company
11. P.A. Janaki Raman, "Robotics and Image Processing An Introduction", Tata McGraw Hill Publishing company Ltd.

12. Richard D Klafter, Thomas A Chmielewski, and Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd.
13. Roland Siegwart, Illah Reza Nourbakhsh, and DavideScaramuzza, "Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA
14. Alonzo Kelly, Karl Iagnemma, and Andrew Howard, "Field and Service Robotics", Springer
15. RiadhSiaer, "The future of Humanoid Robots- Research and applications", Intech Publications

Course Code	Course Name	Credits
AEDLO6023	**AUTOMOTIVE MATERIALS**	**4**

Objectives

1. To familiarize the importance of different classes of materials in making of automobiles
2. To acquaint with improving efficiency of automobiles through proper selection of materials and processing methods.
3. To familiarize the recent trends used in making of various automotive components.

Outcomes: Learner will be able to…

1. Identify the need for new alternative materials to improve efficiency of automobiles.
2. Distinguish between the materials requirements for various types of automobiles.
3. Estimate the role of different classes of materials for various automotive systems
4. Select proper material while designing any automotive subsystem.
5. Select advanced materials for specific automobile components.
6. Comprehend Ashby charts for material selection

Module	Detailed Contents	Hrs.
01	**CONVENTIONAL MATERIALS AND THEIR PROCESSING & NEED OF NEW MATERIALS** Body design concepts with a focus on light weighting, Considerations in the use of Steel and Aluminium for car bodies. Evolution of casting technology, extrusion and sheet forming for making of car bodies for hatchback, utility vehicles, racing cars and heavy vehicles. Light weighting of vehicles with emphasis on material selection. Need to shift to new materials and risks in adopting new materials	**09**
02	**MATERIALS FOR THE INTERIOR** Various high performance plastics and composites used in making of dashboards and their processing. Materials used in Flooring, dashboard silencer, headliner, door trim, baffles, rear shelf and their functionality. Car seat-considerations and materials used. Airbag-materials used and their testing. Fabrics used in upholstery and their properties requirements	**09**
03	**MATERIALS FOR THE EXTERIOR** Application of various new materials including various types of composites in making of car bodies, bonnet, Alloy wheels and the processing method/s used to shape these parts. Reinforcement of fibres in composites - Woven fabrics - Non woven random mats - Various types of fibres in PMC processes - Hand lay-up processes - Spray up processes - Compression moulding - Reinforced reaction injection moulding -Resin transfer moulding -pultrusion- Filament winding - Injection moulding. Fibre reinforced plastics(FRP), Glass fibre reinforced plastics (GFRP)	**09**
04	**PAINTS AND GLASS TECHNOLOGY** Introduction to glass, properties and composition. Various approaches in tempering of glass for improved toughness and shatter resistance. Paint technology: basic concepts and sequences of application and current trends Use of nanoparticles in paints to make self cleaning, scratch resistant paints,nano coatings for corrosion resistance.	**07**

05	**Smart Concepts for Automobiles** Relevance of smart materials in the automobile industry, Recent developments in smart automobiles and Smart engines, Use of Electro- or magneto-rheological engine mounts. Engine blocks-cast iron, aluminium alloys. New trends in engines. Suspension systems: Use of MR fluids and ER fluids in dampers. Fuel Injector materials: high melting point materials-Use of ceramics as fuel injectors. Sintered Friction materials: Powder metallurgy process for making disc brake pads	08
06	**SELECTION OF MATERIALS** Introduction to Ashby charts for making a good selection of materials for different systems in automobiles. Case studies for materials developments by Ferrari, Land Rover, Honda, and FIAT in the making of a automobiles.	06

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

   i.   Question paper will comprise of total six questions.
   ii.   All questions carry equal marks.
   iii.   Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
   iv.   Only four questions need to be solved.

Reference Books:

1. Mathews F.L. and Rawlings R.D., "Composite materials: Engineering and Science", Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., "Composite materials", Springer - Verlag, 1987

Course Code	Course Name	Credits
AEL 601	**Chassis and Body Engineering**	**01**

Objective:

1. To help student understand and model various cross-sections used in chassis frame.
2. To give hands on experience to students on Designing and analysis of Chassis Frame.
3. To familiarize analysis of results from structural analysis of chassis frame.
4. To familiarize analysis of results from modal analysis of chassis frame.
5. To familiarize analysis of results from Harmonic analysis of chassis frame.

Outcome: Learner will be able to
1. Model various cross sections used in Chassis frame.
2. Calculate various loads acting on chassis frame
3. Perform structural analysis of chassis frame
4. Perform modal analysis of chassis frame
5. Perform harmonic analysis of chassis frame.
6. Analyse and understand behaviour of various Chassis cross sections.

Term Work: (Comprises of parts A, B & C)

A. List of Experiments
Analysis of Chassis Frame using any FEA Software's for different sections (C-section, I-section, L-section, O-section, Hat section, Tubular section etc)
1. Structural Analysis of Chassis Frame
2. Modal Analysis of Chassis Frame
3. Harmonic Analysis of Chassis Frame.

B. Mini Project
Analysis of Chassis frame containing a 3D Model of any existing Automobile Chassis or Body or combination of both (Min 2 Max 4 Students per Group)

C. Drawing sheet
Minimum 3 A2 size sheets based on Vehicle body styles layouts for Car body, Bus body and Commercial Vehicle body details.

The distribution of marks for term work shall be as follows:
1) Laboratory work (Experiments)   : **05 marks**
2) Mini project   : **10 marks**
3) Assignment/Drawing sheets   **: 05 marks**
4) 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.

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/Oral based on contents Distribution of marks for practical/Oral examination shall be as follows:

         Practical performance   15 marks
         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

Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEL602	Machine Design –I *	1

Objectives:
1. To study the basic design principles
2. To familiarize with use of design data books & various codes of practice
3. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to....
1. Design shaft under various conditions
2. Design Knuckle Joint / cotter joint
3. Design Screw Jack/C-clamp along with frame
4. Design Flexible flange couplings/ Leaf spring
5. Convert design dimensions into working/manufacturing drawing
6. Use design data book/standard codes to standardise the designed dimensions

Term Work: (Comprises a & b)
   a) **Term work -** Shall consist of (minimum 3) design exercises from the list which may include computer aided drawing on **A3 size sheets**.

        1) Knuckle Joint / cotter joint

        2) Screw Jack

        3) Flexible flange couplings

        4) Leaf springs

        5) C-clamps along with the Frame

   b) **Assignment:** Design exercises in the form of design calculations with sketches and/ or drawings on following machine elements.

        1) Bolted and welded joints

        2) Combined stresses problem using theory of failure.

        3) Shaft design (solid and hollow shaft)

        4) Design against fluctuating loads (finite and infinite life)

The distribution of marks for term work shall be as follows:
- Part - a :   15 marks.
- Part--b :   05 marks.
- Attendance: 05 Marks.

Course Code	Course Name	Credits
AEL603	**FINITE ELEMENT ANALYSIS***	**1**

Objectives:
1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to.....
1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a & b)

a) List of Experiments: Students should use the commercial software or programmes form 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 given below:

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

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.

b) Course Project:

A group of not more than four 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.

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

Part a:	15 marks.
Part b:	05 marks.
Attendance:	05 Marks.

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:
   a. Practical performance: 15 marks.
   b. 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.

Course Code	Course Name	Credits
AEL 604	**Mechanical Vibrations**	**1**

Objectives:
1. To acquaint with the principles of vibration measuring instruments.
2. To get acquainted with the use of data acquisition system (DAQ) and related software and hardware for gathering vibration data on live problem.
3. To study balancing of mechanical systems.

Outcomes: Learner will be able to
1. Estimate natural frequency of mechanical element/ system.
2. Analyse vibration response of mechanical element/system.
3. Determine damping coefficient of a system.
4. Demonstrate the use DAQ system with associated hardware and software to gather vibration data of a system.
5. Handle the vibration measuring instrument.
6. Balance rotating masses.

Term Work:

List of Experiments

Sr. No.	Title of Experiment	Laboratory Sessions
1	Determine natural frequency of compound pendulum, equivalent simple pendulum system.	2 Hrs.
2	Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel	2 Hrs
3	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system	2 Hrs
4	Frequency and acceleration measurements of any one vibrating system using 'National Instruments' Lab VIEW software ,DAQ and accelerometer	2 Hrs
5	Determination of damping coefficient of any system/media	2 Hrs
6	Experimental balancing of single and multi-rotor system	2 Hrs
7	Measurement of vibration response of a system	2 Hrs
8	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave	2 Hrs
9	Experiment using Fullartor or Frahm tachometer to measure frequency of vibration or speed of rotating parts of a machine.	2Hrs
10	Experiment on whirling of shaft.	2 Hrs

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

Project Based Learning may be incorporated by judiciously reducing number of assignments

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.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

   Practical performance   15 marks

   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

Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
AEL 605	**Mechatronics Lab***	**01**

Objectives
1. To study sensors and actuators
2. To study control systems
3. To study automation

Outcomes: Learner will be able to…
1. Demonstrate implementation of interfacing sensors and actuators using microcontrollers
2. Demonstrate of interfacing various utilitieswith microcontrollers
3. Demonstrate discrete control system using PLC microcontroller
4. Design and develop a control system for specific use
5. Implement program to PLC system and demonstrate its application
6. Develop pneumatic circuits for a specific system

The laboratory experiments should be based on the following.**.**

Group 1: Sensors & Actuators

1. Theoretical & Experimental Implementation of Interfacing of Sensors using microcontroller and determination of sensor characteristics such as Static Characteristics (Sensitivity, Accuracy, Range, Resolution etc.), Dynamic Characteristics (Transient Response and Frequency Response)

2. Measurement and Calibration of Load / Force (*It is suggested to determine all characteristics of sensor mentioned in previous experiments)*

3. Measurement, Calibration and Comparison of Temperature Sensors (Thermocouple, RTD and Thermistor) *(It is suggested to determine all characteristics of sensor mentioned in previous experiments)*

4. Interfacing of Stepper Motor with microcontroller and its programming for Rotational or XY table *(It is suggested to program to vary the position of rotary or XY table and compare the positioning accuracy using standard calibrated angular or linear sensor)*

5. Interfacing of DC Motor with microcontroller and its programming for characterization of DC motor setup *(It is suggested to program to vary the speed of DC motor and determine its load-speed characteristics)*

6. Interfacing of Water Heater with microcontroller and its programming for determination of its transient and steady state characteristics *(It is suggested to program to vary the input current to heater and determine its transient and steady state characteristics)*

Group 2: Control Systems

1. Experimental demonstration of Discrete control system using PLC microcontroller using standard PLC demo setup (Bottle filling Machine, Traffic Light Signal, Water heater and its stirring System etc.). *(here it is suggested to carry out ladder programing and demonstrate its operation)*

2. System Identification of Spring Mass Damper System for step input & harmonic input and determination of poles and zeros of system. *(Spring Mass Damper setup with all required position sensors mounted is to be characterized for step input, it is suggested to determine transfer function (i.e. input output relation) of the setup and plotting its transient and frequency response (Bode plot))*

3. Design & Experimental Implementation of PID control strategy for Spring Mass Damper Setup to control precisely position of mass. (*it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system*).

4. Design & Experimental Implementation of PID control strategy for DC motor speed control under varying loading conditions and effect of variation of load is to be studied.

5. Design & Experimental implementation of PID control strategy for Real Time Temperature Control of furnace *(it is suggested to conduct experimental study on effect of variation of controller parameters on its transient characteristics also to study the changes in poles and zeros of system).*

6. Modeling and design of control system for quarter car suspension model using any suitable modeling and analysis software.

Group 3: Automation

1. Real time Logic implementation for traffic Control demo setup and it is necessary to carry out ladder programming and implement program to PLC system and demonstrate its operations

2. IOT: Real time interfacing of sensors (temperature, humidity, position, level etc.) and actuator (stepper motor, dc motor, servo motor etc.) with microcontroller and Ethernet shield and controlling the actuator and monitoring of sensor output remotely using internet.

3. Robotics: Real Time demonstration of line following robot using standard robotic kit

4. Demonstration and study of functions of components of robotics arm.

5. Visualization of DH parameters in Roboanalyzer.(*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com)

6. Designing sequential operation for two cylinders using electro-hydraulic   circuits

7. Designing sequential operation for two cylinders using electro- pneumatic circuits

8. Development of pneumatic circuits to understand pneumatic components and their working

Term work
Term work shall consists of minimum Nine Experiments, Three from each group mentioned above

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

Laboratory Work:	20 marks.
Attendance:	05 Marks.

End Semester Practical /Oral Examination:
1. Pair of Internal and External examiner should conduct Practical/Oral based on contents.
2. Practical examination (in a group of not more than Four students) duration is 2 hours.
3. The distribution of marks for practical / oral examination shall be as follows:
   a. Practical performance: 15 marks.
   b. 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.

Course Code	Course Name	Credits
AEC 701	**Automotive Design**	**4**

Objectives
1. To familiarize with the fundamental knowledge in the field of automotive design.
2. To acquaint with required analytical abilities to provide solutions to design problems.

Outcomes: Learner will be able to…
1. Select and design specific gear pairs for given conditions.
2. Design Gearbox
3. Design various Engine components.
4. Design clutch/brakes with drive lines.
5. Select standard components such as Bearings/belts.
6. Design Cam and follower for given requirement.

Module	Detailed content	Hrs
1	**Design of Gears** Spur, Helical, Bevel and Worm with strength, wear and thermal consideration **Single stage gear box design** consisting of - Spur, Helical, Bevel gear pairs, Housing design	12
2	**Engine design- (Petrol and diesel)** 1. Cylinder and cylinder liner 2. Piston, piston rings and piston pin or gudgeon pin 3. Connecting rod with small and big end bearing 4. Crankshaft and Selection of Bearing.	10
3	**Design of Clutches:** single plate, multiple plates, centrifugal clutch Design of propeller shaft and Axles	08
4	**Design of Brakes:** Energy Absorbed by a Brake, Heat to be dissipated during Braking, Materials for Brake Lining, Single Block or Shoe Brake, Pivoted Block or Shoe Brake, Double Blockor Shoe Brake, Internal expanding Brake.	06
5	**Design of Cam and Follower:** Roller follower mechanism with spring and shaft Design of valves and valve operating mechanism	06
6	**Design and selection of belts**- Flat - belt and V- belt with pulley construction and Roller chain	06

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.
  i.   Question paper will comprise of total six questions.
  ii.   All questions carry equal marks.

iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

iv. Only four questions need to be solved.

NOTE

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

ReferenceBooks:

1. Machine Design Exercises - S.N. Trikha, Khanna Publications, Delhi
2. Design of machine elements - V. B. Bhandari Tata McGraw Hill Pub.
3. Machine Design - An Integrated Approach - Robert L. Norton - Pearson Education Asia.
4. Mechanical Engineering Design - J. E. Shigley - McGraw Hill
5. Machine Design Exercises - S.N. Trikha, Khanna Publications, Delhi
6. Recommended Data Books – PSG and K. Mahadevan
7. Gear Design Handbook - GitinMaitra
8. Material handling equipments - N. Rudenko , Peace Publication
9. Material handling equipments - Alexandrov, MIR Publication
10. Machine Design - Reshetov - Mir Publication
11. Machine Design - Patel, Pandya, Sikh Vol – I & II, C. Jamnadas& Co. Educational & Law Publishers
12. Design of Machine Elements - V.M. Faires.
13. Design of Machine Elements - Spotts.

Course Code	Course Name	Credits
AEC702	CAD/CAM/CAE*	04

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.
3. To develop New API for CAD

Outcome: A learner will be able to….
1. Identify proper computer graphics techniques for geometric modeling.
2. Transform, manipulate objects and store and manage data.
3. CAM Toolpath Creation and NC- G code output.
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. **Application Programming Interface (API)** Concept of customizing applications by writing programs, Fusion Object Model, Creating Scripts and Add-Ins, Document and assembly structure, Attributes, Creating Programs for Assemblies, Joint, B- Rep & Geometry.	08
03	**Design to Manufacturing (CAM)** 2D Machining Strategies, 3D Machining Strategies, Fixture Component Terminology, Work Coordinate System Terminology, Create setups, Apply 2D operations, Facing, 2D adaptive clearing, 2D contour. Chamfer milling, Bore ,Tool simulation and stock material removal , Produce setup sheets , Product NC code via post processing,	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

		Rapid Prototyping and Tooling	
06		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

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **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 Name	Credits
AEC 703	**Autotronics**	**4**

Objectives

1. To study basic and advance Automotive Electronics systems.

2. To acquaint with working of different Automotive Electronics systems and subsystems.

3. To familiarize basic and advance electronics technologies like Battery, Fuel Cell, ECM etc.

Outcomes: Learner will be able to…

1.Illustrate working of different batteries and fuel cells used in automobiles.
2. Demonstrate working of Charging system used in automobiles.
3. Illustrate working of starting system and drives used in automobiles.
4. Draw and Interpret lighting and wiring systems in automobile.
5. Comprehend working of different sensors and actuators used in automobiles.
6.Elaborate working of Electronic control module (ECM) with its importance in vehicle operation.

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**	08

	2.1 Requirements of starting system 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 Multi Point Fuel Injection (from electronic view point 1.7 Common Rail Diesel Injection (from electronic view point **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.	08

	1.2.9 Stepper motors.		
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 ,OBD-II etc.**	08	

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

   i.   Question paper will comprise of total six questions.
   ii.   All questions carry equal marks.
   iii.   Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
   iv.   Only four questions need to be solved.

Reference Books:

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 Name	Credits
AEDLO7031	**Automotive NVH**	**4**

Objectives:
1. To acquaint with concept of Noise, Vibration and Harshness in automotive industry.
2. Study various types of noise and measurement techniques.
3. To familiarize with various sources of noise from automobiles.
4. To acquaint with automotive noise controlling techniques.

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Outcomes: Learner should be able to ….
1. Comprehend the basic concepts of noise and vibration.
2. Demonstrate noise measurements and analyze sound for automotive applications.
3. Apply the concept of design of interiors to maintain NVH levels.
4. Apply noise control techniques to reduce noise.
5. Demonstrate vibration measurements for automobile.
6. Apply vibration isolation and control techniques to automobiles.

Module	Details	Hrs
01	**1.1 Introduction to NVH** Noise, Vibration and Harshness (NVH)—general meaning, and its role in automotive design and development. Physiological effects of noise and vibration. **1.2 Review of Basic Concepts of Vibration Analysis**	06
02	**2.1 Noise Fundamentals** Fundamentals of Acoustics—general sound propagation—structure borne and air borne sounds, plane wave propagation—acoustic near and far fields, reference quantities, the decibel scale, relationship among sound power, sound intensity and sound pressure level, summation of pure tones, decibel addition, subtraction and averaging (numerical treatment), effects of reflecting surfaces on sound propagation, octave band analysis, anatomy of human ear, mechanism of hearing, loudness, weighting networks, equivalent sound level.	12
03	**3.1 Automotive Noise Sources** Noise characteristics of engines, Engine overall noise levels, Assessment of the noise sources viz.—Engine noise, Intake and Exhaust noise, Tyre/Road noise, Aerodynamic sound sources in vehicles, Transmission and Gearbox noise, Brake noise. Acoustical Design of Mufflers. **3.2 Automotive Noise Control Techniques** Noise control strategies, Noise control at source—along the path—isolation, damping, balancing, resonators, sound energy absorption, sound transmission through barriers, enclosures.	12
04	**4.1 Vibration Control and Measurement Techniques** Review of Vibration Control Techniques: Dampers—various types, Vibration Isolation, Frequency and Seismic measuring instruments. Vibration Absorber, Tuned and Untuned viscous dampers, Centrifugal Pendulum.	06
05	**5.1 Case Studies** Vibration Control and Measurement Techniques—for e.g., Isolation of engine from vehicle structure and Control of torsional oscillation amplitudes in engine crankshaft, etc.	04
06	**6.1 NVH Measurements** Vibration and Noise Standards – Pass/Drive by noise, noise from stationary vehicles, interior noise in vehicles, NVH measurement tools and techniques, Modal parameter (natural frequency, mode shape and damping) estimation techniques, signal and system analysis.	08

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.
  i.   Question paper will comprise of total six questions.
  ii. All questions carry equal marks.
  iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
  iv. Only four questions need to be solved.

Text and Reference Books:
1. Norton M. P., Fundamental of Noise and Vibration, Cambridge University Press, 1989.
2. Clarence W. de Silva ―Vibration Monitoring, Testing, and Instrumentation, CRC Press, 2007.
3. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987.
4. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
5. Ewins D. J., Model Testing: Theory and Practice, John Wiley, 1995.
6. McConnell K, "Vibration Testing Theory and Practice", John Wiley, 1995.
7. Allan G. Piersol, Thomas L. Paez ―Harris' shock and vibration hand book, McGraw-Hill, New Delhi, 2010.
8. David A. Bies and Colin H.Hansen ―Engineering Noise Control: Theory and Practice, Spon Press, London 2009.
9. Colin H Hansen ―Understanding Active Noise Cancellation, Spon Press, London. 2003
10. Matthew Harrison ―Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Elsevier Butterworth-Heinemann, Burlington, 2004.
11. Xu Wang ―Vehicle Noise and Vibration Refinement, CRC Press, 2010.
12. Bell, L. H. and Bell, D. H., "Industrial Noise Control – Fundamentals and Applications", Marcel Dekker Inc, New York, 1994.
13. Ambekar, A. G., "Mechanical Vibrations and Noise Engineering", Prentice Hall of India, New Delhi, 2006.
14. Beranek, L. L. and Ver. I. L., "Noise and Vibration Control Engineering – Principles and Application", John Wiley & Sons Inc., 1992.
15. Wilson, C. E., "Noise Control – Measurement, Analysis, and Control of Sound and Vibration", Harper & Row Publishers, New York, 1989.
16. Thomson, W. T., "Theory of Vibrations with Applications", CBS Publishers, Delhi
17. Singiresu S.Rao - "Mechanical Vibrations" - Pearson Education,2004.
18. Kewal Pujara "Vibrations and Noise for Engineers", Dhanpat Rai & Sons, 1992.

Course Code	Course Name	Credits
AEDLO7032	**Automotive Embedded Systems**	**4**

Objectives

1. To provide broad introduction to automotive embedded systems
2. To provide a comprehensive overview about existing and future automotive electronic systems.

Outcomes: Learner will be able to…

1. Illustrate basic concepts of embedded systems
2. Comprehend the various types of communication protocols used in Automobiles
3. Demonstrate various types of X by wire technologies with its challenges and opportunities
4. Identify various hardware modules used in embedded system.
5. Recognize Tools for software development from Automobile viewpoint.
6. Comprehend embedded systems used in automobiles using different case studies.

Module	Detailed Contents	Hrs.
01	**Introduction** Introduction to functional building blocks of embedded systems – Register, memory devices,ports, timer, interrupt controllers using circuit block diagram representation for each categories –Devices & buses for devices network - serial communication using I2C, CAN, USB buses – parallelcommunication using ISA, PCI - device drivers in a system – Serial port & parallel port.	08
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	08
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	08
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	08
06	**Integration of Software and Hardware** Downloading the software from Host Machine to target Machine, Implementing Application Prototype: Power windows and automotive lighting system	08

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

   i.   Question paper will comprise of total six questions.

   ii.   All questions carry equal marks.

   iii.   Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

   iv.   Only four questions need to be solved.

Reference Books:

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

Course Code	Course Name	Credits
AEDLO7033	Automotive Aerodynamics and Aesthetics	4

Objectives

1. To familiarize the fundamentals of fluid mechanics related to vehicles.
2. To acquaint with concepts of the aerodynamics drag of cars.
3. To familiarize with the basic principles of wind tunnel technology.

Outcomes: Learner will be able to…

1. Illustrate various flow phenomenon related to vehicles.
2. Demonstrate and analyze different types of drag forces.
3. Optimize various shape configurations in automobiles.
4. Illustrate the principle of wind tunnel technology.
5. Comprehend stability of vehicle under aerodynamics forces.
6. Demonstrate various techniques used for drag reduction.

Module	Detailed Contents	Hrs.
01	**Introduction**-Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.	08
02	**AERODYNAMIC DRAG OF CARS**-Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles.	08
03	**Shape Optimization of Cars**--Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners.	08
04	**Vehicle Handling**--The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles.	08
05	**Wind Tunnel for Automotive Aerodynamics**--Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, road testing methods, numerical methods.	08
06	**Automobile Aesthetics**- Design concepts of consumer products, specification requirements and rating of their importance in design, functions and use, standard and legal requirements, body/dimensions. Ergonomic considerations, interpretation of information, conversions for style, forms, colors.	08

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

  i.   Question paper will comprise of total six questions.
 ii.   All questions carry equal marks.
iii.   Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
 iv.   Only four questions need to be solved.

Reference Books:

1. Hucho.W.H. - "Aerodynamic of Road Vehicles" - Butterworth's Co., Ltd., - 1997.
2. A. Pope - "Wind Tunnel Testing"- John Wiley & Sons - 2nd Edition, New York - 1974.
3. Automotive Aerodynamic: Update SP-706 - SAE - 1987
4. Vehicle Aerodynamics - SP-1145 - SAE – 1996.
5. Product Design and Development by AK Chitale and Gupta

Course Code	Course Name	Credits
AEDLO7034	**Computational Fluid Dynamics***	**4**

Objectives

1. To study basic principles of Computational Fluid Dynamics
2. To study grid generation and discretization methods

Outcomes: Learner will be able to…

1. Demonstrate methodology to work with CFD
2. Illustrate principles of grid generation and discritisation methods
3. Identify and apply specific boundary conditions relevant to specific application
4. Decide solution parameters relevant to specific application
5. Analyze the results and draw the appropriate inferences
6. Demonstrate basic principles of FVM

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 Software, 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 Discretization Concept, The Structure of the Discritization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. 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.	
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	**Finite Volume Methods**: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	08

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **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 Delhi
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
9. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
10. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

Course Code	Course Name	Credits
ILO 7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life	05

	Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

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4. Only **Four questions need to be solved**.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	**Design of Experiments**	**03**

Objectives:
1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…
1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent	07

	5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

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4. Only **Four questions need to be solved**.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	**Operations Research**	**03**

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05

04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:
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End Semester Examination:
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2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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4. Only **Four questions need to be solved**.

REFERENCES:

1. Nina Godbole, SunitBelapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction *1.1* Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management	09

	of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

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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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.
(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10

05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rdCAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10

6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

  0. Question paper will comprise of total **six questions**, **each carrying 20 marks**
  1. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
  2. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
  3. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, AmericanPlanningAssociation, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Subject Code	Course Name	Credits
AEL 701	**Automotive Design Lab**	**01**

Objectives:
1. To familiarize with basic concept of design for designing the automotive components
2. To acquaint with preparation of working drawings based on designs.

Outcomes: Learner will be able to...
1. Demonstrate understanding of various design consideration
2. Apply basic design concepts for safe working of parts in automotive system.
3. Prepare production drawings pertaining to various designs.
4. Select appropriate materials for various components of the mechanical systems.
5. Demonstratedesign calculations for various automotive components.
6. Analyze various automotivesystems using standard analysis software's.

Laboratory shall comprise of:
1. Minimum six exercises on the following in the form ofdesign calculations.
    a. Single stage gear box design including gear box housing.
    b. Single cylinder petrol engine.
    c. Single cylinder diesel engine.
    d. Design of single-plate clutch
    e. Design of multi-plate clutch
    f. Design of Brake.
    g. Design of cam and follower
    h. Design of Flat - belt and V- belt with pulley construction
    i. Design of Roller chain

2. Design and detailed assembly drawing of minimum two design problems, from the following. (Computer aided drawing on **A- 3 size sheets).**
    a. Single stage gear box design including gear box housing
    b. Single cylinder petrol engine.
    c. Single cylinder diesel engine.
    d. Design of single-plate clutch
    e. Design of multi-plate clutch
3. **Course project**: Students in a group of two to four will be able to design and prepare working drawings of any automotive component by applying the knowledge gained during the course.

The distribution of marks for lab work shall be as follows:
1. Exercises &CAD Drawing Sheets   : 15 Marks
2. Course Project   : 05 Marks
3. Attendance (Theory & Practical)   : 05 Marks

The final certification and acceptance of Lab 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, Design Data by Mahadevan, and Design data by Kale Khandhare is permitted at the examination and shall be supplied by the institute.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

   Practical performance   15 marks

   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

Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEL702	**CAD/CAM/CAE***	**01**

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.
3. To develop New API for CAD

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. CAM Toolpath Creation and NC- G code output.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

List of Exercises
1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

Term Work
Term work shall consist of
   a) Any fourexercises from 1 to 6 of the above list
   b) Part programming and part fabrication on CNC trainer.
   c) A course project in a group of not more than four students on 8 and 9 of above list.

The distribution of marks for term work shall be as follows:
   • Exercises   : 15 Marks
   • Course Project   : 05 Marks
   • Attendance   : 05 Marks

Practical/Oral examination
1. Each student will be given a small task of design based on syllabus, which will be assessed by examiners during the oral examination.
2. The distribution of marks for oral-practical examination shall be as follows:
                Design Task: 15 marks
                Oral: 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Course Name	Credits
AEL 703	**Autotronics**	**01**

Objectives:
1. To acquaint with working of Automotive Batteries
2. To acquaint with working principle of Charging ,Starting system
3. To familiarize the function and location of various Sensors and Actuators
4. To acquaint with wiring and Lighting system in Automobiles.

Outcomes: Learner should be able to…

1. Illustrate working of Automotive batteries and its types
2. Dismantle and Assemble A.C Generator/Dynamo
3. Dismantle and Assemble starter motor
4. Measure temperature using sensor
5. Measure pressure using sensor
6. Measure Oxygen using sensor.

The laboratory assignments should be based on the following:

List of Experiments

1. Study of Lead Acid Battery.
2. Battery testing: Voltagetest, Hydrometer test etc.
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 effect of spark advances on the Engine Emissions.
10. Study of Electro-magnetic fuel Injector.
11.Testing of Spark Plug.

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:
1) Laboratory work (Experiments)   **: 10 marks**
2) Assignments   : **10 marks**
3) 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.

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

        Oral   25 marks

Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEC 801	**Vehicle Maintenance**	**3**

Objectives

1. To study basic types of vehicle maintenance along with its importance.

2. To become aware about workshop skills and career opportunities available in Automobile Industry.

3. To acquaint with various Trouble shooting, fault tracing practices available in automobile industry.

Outcomes: Learner will be able to…

1. Demonstrate the maintenance procedure for automotive Engine and prepare checklist.

2. Comprehend of the operation of OBD for diagnosing various faults.

3. Identify the trouble diagnosis procedure for steering and suspension system.

4. Illustrate the trouble diagnosis procedure for electrical systems like Battery, starting

   Systems etc.

5. Illustrate trouble diagnosis procedure for lubrication and fuel delivery system etc.

6. Illustrate trouble diagnosis procedure for heating system of automobile.

Module	Detailed Contents	Hrs.
01	**Types of Maintenance** **Automotive Engine Diagnosis:** 1.1 Lower End Theory and Service ✓ Short Block Disassembly ✓ Cylinder Block and its Reconditioning ✓ Camshaft, Crankshaft, Crankshaft Inspection and Rebuilding ✓ Installing Main Bearings and Crankshaft ✓ Piston and Piston Rings ✓ Installing Pistons and Connecting Rods ✓ Inspection and Installation of Camshaft and Related Parts ✓ Crankshaft and Camshaft Timing 1.2 Upper End Theory and Service ■Cylinder Head ■ Combustion Chamber ■ Intake and Exhaust Valves ■Variable Valve Timing ■ Cylinder Head Disassembly ■ Inspection of the Valve Train ■ Servicing Cylinder Heads ■ Reconditioning Valves ■ Valve Guide Reconditioning ■ Reconditioning Valve Seats ■Valve Stem Seals ■ Assembling the Cylinder Head 1.3 Preparation of check lists, Inspection schedule, maintenance of records, log sheets and other forms	05
02	**Maintenance of Engine Accessories** 2.1 Emission control system (SI & CI): Theory, Diagnosis and service 2.2 Restraint system : Theory, Diagnosis and service	06

	2.3 OBD-I and OBD-II: Theory and various systems to diagnose the engine faults.	

03	**Maintenance of Automotive Systems**
	
	  3.1 Manual & Automatic Transmission: Diagnosis and service
	  3.2 Steering system: Diagnosis service
	  3.3 Suspension system: Diagnosis service
	  3.4 Braking system : Theory, Diagnosis and service
	  3.5 Tires and wheels: Diagnosis and service
		10

04	**Maintenance of Automobile Electronics Components and Accessories** 4.1 Batteries: Diagnosis and service ■ Servicing and Testing Batteries ■ Isolating High-Voltage Systems ■ Jump-Starting 4.2 Charging system Diagnosis and service 4.3 Starting system Diagnosis and service 4.4 Electrical Instrumentation and Electrical accessories ■ Windshield Wiper/Washer Systems ■ Horns/Clocks/Cigarette Lighter Systems ■ Cruise (Speed) Control Systems ■ Sound Systems ■ Power Lock Systems ■ Power Windows ■ Power Seats ■ Power Mirror System ■ Rear-Window Defrosters and Heated Mirror Systems ■ Other electronic Equipment ■ Security and Antitheft Devices	08

05	**Maintenance of Lubrication ,Cooling ,Fuel Delivery Lubrication System Diagnosis and service**
	5.2 Lubrication system : Theory , Diagnosis and service
	5.2 Cooling System : Theory , Diagnosis and service
	  ✓ Inspection of Cooling System
	  ✓ Testing for Leaks
	  ✓ Cooling System Service
	5.3 Fuel delivery system diagnosis and service
		06

06	**Maintenance of Heating and air conditioning Systems& career opportunities**
	  ➢ **Maintenance of Heating and air conditioning Systems**
	    6.1 Ventilation System
	    6.2 Automotive Heating Systems
	    6.3 Heating System Service
	    6.4 Theory of Automotive Air-Conditioning Refrigerants
	    6.5 Basic Operation of an Air-Conditioning System
	    6.6 Air-Conditioning Systems and Controls
	    6.7 Temperature Control Systems
	  ➢ **Air conditioning and diagnostic service**
		04

	6.8 Service Precautions	
	6.9 Refrigerant Safety Precautions Guidelines for Converting (Retrofitting) R-12 Systems to R-134a	
	6.10 Initial System Checks Diagnosis	
	6.11 Performance Testing Leak Testing	
	6.12 Recharging the System Climate Control Systems	
	➢ **Career opportunities**	
	6.13 Training for a Career in Automotive Service Industry	
	6.14 ASE Certification: Opportunities under Make in India initiatives	

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

  i.   Question paper will comprise of total six questions.
  ii. All questions carry equal marks.
  iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
  iv. Only four questions need to be solved.

Reference Books:

1. James D Halderman - Advanced Engine Performance Diagnosis – PHI - 1998.

2. Service Manuals from Different Vehicle Manufacturers.

3. Automotive Trouble shooting and Maintenance by Anderson Ashburn.

4. Venk. Spicer, Automotive Maintenance and Trouble shooting.

5. Automotive Technology :A Systems Approach, 5e Jack Erjavec/Delmar Cengage Learning.

6. Automotive Mechanics, William Crouse and Donald Anglin /TATA Mc Graw-hill.

7. Automotive Technology, Joseph Heitner.

8. Automotive Electrical and Electronic Systems by John F. Kershaw, James D.Halderman.

Course Code	Course Name	Credits
AEC 802	Vehicle Dynamics	4

Objectives
1. To familiarize with basic concepts of vehicle dynamics.
2. To acquaint with concepts of stability of vehicles and their effects.

Outcomes: Learner will be able to…
1. Analyze the vehicle directional stability.
2. Enumerate the suspension systems, tire dynamics & directional stability of the vehicle.
3. Develop physical and mathematical models to predict the dynamic response of vehicles
4. Demonstrate the ride characteristic of the vehicle.
5. Analyze the vehicle roll behaviour
6. Comprehend the various trends in Vehicle Dynamics.

Module	Detailed Contents	Hrs.
01	**Introduction** History of Road and Off Road Vehicle System dynamics, Equation of Simple Spring Mass System of Two Masses, Motion after the Hump, Acceleration for stepped input, Single Mass system of Two degree of freedom, Conjugate Points, Elastic, Dynamic, doubly Conjugate Points, Calculation of Conjugate Points, Road Load, Aerodynamics-Drag, Side force, Lift force, Rolling Resistance, Total Road Loads,	08
02	**Tyres** SAE Tyre axis system, Tyre forces, Moments, Lateral force V/S Slip Angle, Aligning Torque V/S Slip Angle, Tyre Construction, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined and Cornering, Conicity and Ply Steer, Tire Vibration, Tyre Properties affecting Vehicle Roll over, Introduction to Magic Tyre Formula.	08
03	**Suspension** Solid Axles, Independent suspensions, Anti Squat and Anti Pitch Suspension Geometry, Anti Drive Suspension Geometry, Roll Centre Analysis, Active Suspension, Motion Analysis of Wheel Suspension. Equalizing Suspension, Variable Rate Leaf Spring.	08
04	**Ride** Sources for vehicle vibration, vibration isolation, Effects of damping the vibration, vibration absorbers, pitch and bounce motion frequencies.	08
05	**Steering** Steering geometry, Front wheel geometry, Steering system forces and moments, Steering system effects, Influence of front wheel drive, Four wheel steering, Suspension effect of cornering, Steady state and Transient behaviour.	08
06	**Recent Trends in Vehicle dynamics** Vehicle dynamic Control, Modelling of Actuators, Sensors for Automobile Control, Sensors for Detecting Vehicle Environment, Central Tyre Inflation system.	08

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

  i.   Question paper will comprise of total six questions.
  ii.   All questions carry equal marks.
  iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
  iv.   Only four questions need to be solved.

Reference Books:

1. Gillespie T.D, ―Fundamentals of Vehicle Dynamics‖, SAE USA 1992
2. Giri N.K – Automotive Mechanics, Khanna Publishers, 2007.
3. Road and Off Road Vehicle system Dynamics: Hand Book
4. Mechanics of Road Vehicle: Steeds
5. Automobile Suspension and Handling : Colin Campell
6. Car Suspension : Bastow
7. Race Car Vehicle Dynamics: William F Milliken and Douglas L Milliken

Other references:

1. J. Y. Wong, "Theory of Ground Vehicles", 3rd ed., John Willey & Sons, New York, 1997.
2. Ham B, Pacejka - Tyre and Vehicle Dynamics - SAE Publication – 2002
3. Heinz Heisler, "Advanced Vehicle Technology ", 2nd Edition, Butterworth-Heinemann, 2002

Course Code	Course Name	Credits
AEC 803	**VEHICLE SAFETY**	**3**

Objectives:
1. To familiarize with basic concepts of vehicle safety
2. To familiarize accident reconstruction analysis methods
3. To acquaint with different issues related to vehicle safety in India and Abroad.

Outcomes: Learner will be able to
1. Comprehend Vehicle design from safety point of view.
2. Apply concepts of accident reconstruction analysis in real world.
3. Enumerate interrelation ship among occupant, restraint systems and vehicles in accidents.
4. Illustraterole and significance of seat in Rear crash safety
5. Demonstrate different active and passive safety systems available in vehicles
6. Illustrate various standards related to vehicle safety.

Module	Detailed Contents	Hrs.
01	Introduction to vehicle safety Basic concepts of vehicle safety Risk evaluation and communication Human error control Universal design The distracted driver Crash Testing	06
02	Accident Data Biomechanics and Occupant Simulation Vehicle Body Testing Dynamic Vehicle Simulation Tests Occupant Protection Pedestrian Protection Compatibility Interrelationship Among Occupants, Restraint Systems and Vehicle in Accidents	06
03	Significance of Rear Crash Safety Role of seat in Rear crash safety Performance criteria for different seats Ultra high Retention seats	08
04	Introduction to Accident Analysis Reconstruction methods Uncertainty in Measurement and cautions Tire forces Straight-line Motion Critical speed from Tire Yaw marks Reconstruction of Vehicular Rollover Accidents Analysis of Collisions Reconstruction Applications Impulse Momentum Theory Crush Energy Frontal Vehicle –Pedestrian Collision Photogrammetry for accident constructions	10

05	Antilock braking system Traction control system Electronic Stability Program Low tire pressure warning system Collision avoidance systems	04
06	Automotive Industry Standards Transport EngineeringStandards Indian road congress Standards	04

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

    i.   Question paper will comprise of total six questions.
    ii.   All questions carry equal marks.
    iii.   Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
    iv.   Only four questions need to be solved.

References Books:

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 LotharWech, SAE International, 2007.
6. Public Safety Standards of the Republic of India

Course Code	Course Name	Credits
AEDLOC8041	**Hybrid Electric and Fuel Cell Vehicles**	**4**

Objectives
1. To familiarize with basic Concepts of Hybrid, Electric and Fuel Cell vehicles.
2. To acquaint with various aspects of hybrid and electric drive train
3. To study various challenges involved with Fuel cell technology.

Outcomes: Learner will be able to…
1. Illustrate different types of Fuel cells, its operation, and performance.
2. Quantify fuel cell processing using codes and standards.
3. Comprehend basic concept of Hybrid and Electric traction.
4. Illustrate various Architectures related to Hybrid Drive train.
5. Illustrate need and environmental importance of Hybrid technology.
6. Analyse hybrid vehicles.

Module	Detailed Contents	Hrs.
01	**Fuel Cell Technology**-Unit Cells, Fuel cell stacking, Fuel cell Types (Polymer Electrolyte Fuel cell, Alkaline Fuel cell, Phosphoric acid Fuel cell, Molten carbonate fuel cell, and Solid oxide fuel cell), and Timeline of introduction of fuel cell technology in automobiles.	04
02	**Fuel Cell Performance**-Role of Gibbs free energy and Nernst Potential, Cell Energy balance, Cell efficiency, Performance variables, various mathematical models.	04
03	Polymer Electrolyte Fuel cell-Cell Components,PEFC systems Alkaline Fuel Cell-Cell component, Performance Introduction to Fuel cell Hybrids, Fuel cell Auxiliary Power Systems Sample Calculations-Fuel cell Calculations, Fuel Processing Calculations for PEFC,AFC.Fuel cell related codes and Standards	08
04	**Hybrid Electric Technology and Electric drive trains**-Introduction,History,Environmental importance, Basic concept of Hybrid Traction, Basic concept of electric traction, Introduction of electric components used in electric vehicles,	06
05	Principles of Hybrid Electric Drive trains, Architectures – Electrical distribution, Hybrid control Strategies – Parallel Hybrid, Series Hybrid - (Charge Sustaining, Charge Depleting), Practical Models – Toyota Prius, Honda Insight. Hybridization Effects. 42 V System for Traction Applications - Lightly Hybridized vehicles, Low–Voltage Storage System, Low –Voltage main system with High voltage bus for propulsion.	08
06	**Hybrid Vehicle Technology**-Sizing the drive system: Matching the electric machine and the internalcombustion engine (ICE), Sizing the propulsion motor, sizing the powerelectronics, selecting the energy storage technology, Communications, supportingsubsystems. Energy Management Strategies in hybrid and electric vehicles,classification of different energy management strategies, comparison of differentenergy management strategies, implementation issues of energy managementstrategies. **Case Studies**: Design of a Hybrid Electric Vehicle (HEV), Design of aBattery Electric Vehicle (BEV).	08

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.
   i.   Question paper will comprise of total six questions.
   ii. All questions carry equal marks.
   iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
   iv. Only four questions need to be solved.

Reference Books:

1) Hoogers, G., Edr. *"Fuel Cell Technology Handbook"*, CRC Press, Washington D. C., 2003
2) Larminie, J. and Dicks, A., "*Fuel Cell Systems Explained"* John Wiley & Sons, Ltd., New York, 2001.
3) Fuel Cell Handbook by EG &G Technical Services,Inc.Seventh Edition
4) Ali Emadi, Mehrdad Ehsani, John M. Muller, "*Vehicular Electric Power Systems"*, Marcel Dekker, Inc., 2004.

Course Code	Course Name	Credits
AEDLO8042	**Rapid Prototyping***	**04**

Objectives
1. To familiarise with importance of Rapid Prototyping in Product Development.
2. To acquaint with the Synergic Integration Technologies

Outcomes: Learner will be able to…
1. Select the feasible RP process
2. Selct the feasible RP material
3. Gauge and Hybridize the ever-evolving Protoyping Technologies
4. Contribute towards the Product Development at the respective domain in the industry
5. Apply RP to build working prototypes
6. Demonstrate basics of virtual reality

Module	Detailed Contents	Hrs.
01	Introduction: Product Development Cycle and the product Life Cycle. Problems in Product Development and the use of Synergic Integration Technologies. Relationship between Product Development Cost and the Selling Price. Where does RP stand. Classification of RP systems, advantages and limitations of RP, Applications and scope of RP, supported file formats and introduction to Solid Modelling.	10
02	Laminated Object Manufacturing (LOM), principle of operation, possible approaches, steps, advantages and limitations. Stadard Machine Specifications. Fused Deposition Modelling (FDM), principle of operation, process steps, advantages and limitations. Stadard Machine Specifications. Stereolithography Apparatus (SLA): Principle, process steps, advantages and limitations, Stadard Machine Specifications. Selective Laser Sintering (SLS): Principle, process steps, advantages and limitations, Stadard Machine Specifications.	12
03	Solid Ground Curing (SGC): Principle, process steps, advantages and limitations, PhotoMasking comparative with SLA and LOM ObJet: Principle, process steps, advantages and limitations, applications, Stadard Machine Specifications. 3D Printing: Principle, process steps, advantages and limitations, classification of printer family, Stadard Machine Specifications, DIY procedures.	12
04	Rapid Tooling: Need for metallic tooling, approaches, RP Processes for Tooling, Silicon Rubber Molding, Epoxy Tooling, Spray Metal Tooling, Cast Kirksite Tooling, 3D KelTool, QuickCast.	05
05	Materials for Rapid Prototyping Systems: Nature of material, types of material; polymers, metals, ceramics and composites, liquid based materials; photo polymer development, solid based materials; powder based materials.	05
06	Reverse Engineering: Introduction to Digitizing Methods; contact type and non-contact type, brief introduction to the types of medical imaging. Virtual reality: Definition, features of VR, Technologies used in VR, Introduction to Augmented reality.	04

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**

References:

1. Rapid Prototyping, Principles and Applications byRafiqI. Noorani, Wiley & Sons
2. Rapid Prototyping: Principles and Applications byChua C.K, Leong K.F and Lim C.S, 2nd Edition, World Scientific
3. Rapid Manufacturing – An Industrialrevolution for the digital age by N.Hopkinson, R.J. M.Hauge, P M, Dickens, Wiley
4. Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping byIan Gibson, Wiley
5. Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography byPaul F.Jacobs, McGraw Hill
6. Rapid Manufacturing byPham D T and Dimov SS, Springer Verlog

Course Code	Course Name	Credits
AEDLO8043	**Product Design and Development**	**4**

Objectives

1. To familiarize with basic concepts of product design
2. To acquaint with product design methodologies
3. To acquaint with product design needs and issues in industry

Outcomes: Learner will be able to…

1. Demonstrate product design and development process.
2. Illustrate considerations of Design for Manufacturing and Assembly in product development.
3. Analyze a product in perspective of aesthetic and ergonomic considerations.
4. Illustrate concepts of QFD aspects in product development.
5. Demonstrate applicability of value engineering in product optimization.
6. Demonstrate legal and social issues pertaining to product development.

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	06

	5.5 Comfort criteria. 5.6 Psychological & Physiological considerations. 5.7 Economic factors.	
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

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.
  i.   Question paper will comprise of total six questions.
  ii.   All questions carry equal marks.
  iii.   Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
  iv.   Only four questions need to be solved.

Reference Books:

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 Name	Credits
AEDLO8044	Transportation Management & Motor Industry	4

Objectives:

1. To familiarize with basic concepts of transport management
2. To acquaint with different types of motor insurance.

Outcomes: Learner will be able to…

1. Demonstrate transport management systems
2. Implement advance techniques in traffic management
3. Demonstrate understanding of motor vehicle act.
4. Interpret about vehicle insurance and taxation.
5. Illustrate the knowledge of Passenger transport operation.
6. Illustrate the knowledge of Goods transport operation

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 Personnel, Authorities & duties 1.15 Rules regarding construction of motor vehicles 1.16 Tourist and National Permits 1.17 Fitness of a Motor Vehicle 1.18 Rules for Special Purpose Vehicle(Off Road vehicle, Specially designed vehicle ,Government Department Vehicle)	10
02	**2. Taxation** 2.1 Objectives 2.2 Structure & methods of laving taxation 2.3 One-time tax 2.4 Tax exemption & tax renewal 2.5 Types of Tax 2.6 Different types of Tax at Vehicle Registration Renewal	10
03	**3. Insurance** 3.1 Insurance types & significance 3.1.1 Comprehensive plus zero depreciation 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	08

	3.7 Surveyor & Loss Assessor, Surveyor's report 3.8 Role of Surveyor 3.9 Settlement of Insurance and Procedure of Investigation	
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. 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 4.14 Maintenance management of State Transport Undertaking (STU) 4.15 Bus Rapid Transport system (BRTS)	10
05	**5. Goods Transport Operation** 5.1 Scheduling of goods transport 5.2 Management Information System (MIS) in passenger / goods transport operation 5.3 Storage & transportation of petroleum products 5.4 Intelligent Transport System (ITS)	06
06	**6. Advance Techniques in Traffic Management** 6.1 Traffic navigation 6.2 Global positioning system	04

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

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End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

   i.   Question paper will comprise of total six questions.
   ii. All questions carry equal marks.
   iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
   iv. Only four questions need to be solved.

Reference Books:
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.
4. CMVR-1989
5. Peter R. White: Public Transport: Its Planning, Management and operation (Natural and Built Environment Series, Kindle Edition, September 2008.)
6. John Doke-Fleet Management
7. Kitchin L.D. - Bus Operation, Illiffe and sons Co. London, III edition

Course Code	Course Name	Credits
ILO 8021	Project Management	03

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 appraise the students with the project management life cycle 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 Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8

06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, 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.	6

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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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 any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd

2. A Guide to the Project Management Body of Knowledge (PMBOK$^{®}$ Guide), 5th Ed, Project Management Institute PA, USA

3. Gido Clements, Project Management, Cengage Learning

4. Gopalan, Project Management, , Wiley India

5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO 8022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	05

	Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:
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End Semester Examination:
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4. Only **Four questions need to be solved**.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	**Entrepreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

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End Semester Examination:

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4. Only **Four questions need to be solved**.

REFERENCES:

1. PoornimaCharantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. LaghuUdyogSamachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	**Human Resource Management**	**03**

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning**	5

	• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	**Professional Ethics and Corporate Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
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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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3**. Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached	**04**

| **6.2** Validity Testing & Ethical Issues | |
| **6.3** Suggestions and Recommendation | |

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 8028	**Digital Business Management**	**03**

Objectives:
1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..
1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. A textbook on E-commerce, ErArunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved**.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Credits
AEL 801	**Automotive Workshop**	**02**

Objectives:

    1. To acquaint with Vehicle maintenance practices by hands on training on actual Vehicle.

     2. To familiarize with fault diagnosis techniques used in automobiles.

Outcomes: Learners will be able to

        1. Draw layout of automobile workshop and its usefulness.

        2. Identify the various faults in engine system on actual vehicle in workshop.

        3. Perform Computerized Wheel alignment Process.

        4. Perform Wheel Balancing process.

        5. Perform removal and re fitting of tire using automatic tire changer.

        6.Demonstrate different body repairing and re-conditioning methods.

The laboratory assignments should be based on the following:

1. Prepare a layout of an automobile repair, service and maintenance shop.
2. Prepare different statements/records required for the repair and maintenance works.
3. Prepare the list of different types of tools and instruments required for maintenance.
4. Perform Minor and major tune up activity of gasoline and diesel engines.
5. Detect faults using Fault diagnosis techniques in electrical ignition system, gasoline fuel system, diesel fuel system.
6. Identify and rectify faults in the electrical systems such as Head lights, Side of Parking lights, Electric horn system, Windscreen wiper system, Starter system and charging system.
7. Check and clean fuel filters (both gasoline and diesel engines) and air cleaners (dry and wet).
8. Simple tinkering, soldering works of body panels, study of door lock and window glass rising mechanisms.
9. Perform wheel balancing on a computerized wheel balancer.
10. Perform wheel alignment activity to set proper steering geometry.
11. Perform removal and refitting of tyre using an automatic tyre changer.

Assessment:
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:
1) Laboratory work (Experiments)   **: 10 marks**
2) Assignments   : **10 marks**
3) 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.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

   Practical performance   15 marks

   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

Students work along with evaluation report to be preserved till the next examination

Subject Code	Subject Name	Credits
AEL 802	**Vehicle Dynamics Lab**	**01**

Objectives:

1. To familiarize with basic concepts of vehicle dynamics.
2. To acquaint with simulation process using software in domain of vehicle dynamics.

Outcomes: Learners will be able to

1. Plot performance characteristic curves for shock absorber.
2. Simulate ride behaviour using quarter car model
3. Simulate ride behaviour using half car model
4. Simulate using different road profiles for quarter car and half car model.
5. Calculate drag coefficient for different vehicles
6. Perform test on chassis dynamometer.

List of Experiments:

1. To plot characteristic curves for shock absorber.
2. Simulation of Quarter car model for pitch and bounce.
3. Simulation of Quarter car model for different road profiles
4. Simulation of Half car model for pitch and bounce.
5. Simulation of Half car model for different road profiles.
6. Experimental studies of measurements of drag and lift coefficient for different geometry vehicle using wind tunnel apparatus.
7. To perform test on chassis dynamometer.

Term Work:

Term work shall consist of 7 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:
1) Laboratory work (Experiments)   **: 10 marks**

2) Assignments/Mini Project   : **10 marks**

3) 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.

End Semester Practical/Oral Examination:
1. Pair of Internal and External Examiner should conduct practical/viva based on contents Distribution of marks for practical/viva examination shall be as follows:

      Practical performance   15 marks

      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

Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEP701/ AEP801	**Project (I and II)**	**03 + 06**

Objectives:
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

Outcomes: 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/analyse 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
1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. 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
1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. 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

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.