

U.P. TECHNICAL UNIVERSITY, LUCKNOW



2nd , 3rd and 4th Year
[Effective from session 2009-10]

(With modified course structure of VI & VIII Semester)

B. Tech. Automobile Engineering

U.P. TECHNICAL UNIVERSITY, LUCKNOW

STUDY & EVALUATION SCHEME

B. Tech. Mechanical Engineering / Production Engineering / Industrial & Production Engineering / Mechanical & Industrial Engineering / Manufacturing Technology / Automobile Engineering / Aeronautical Engineering

[Effective Form session 2009-10]

YEAR II, SEMESTER-III

S. No	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						CT	TA	Total			
THEORY											
1	EHU - 301/ EHU - 302	Industrial Psychology/ Industrial Sociology	2	0	0	15	10	25	50	75	2
2	EAS - 301/ EOE 031 - EOE 038	Mathematics III / Science Based open elective***	3	1	0	30	20	50	100	150	4
3	ECE - 301	Fluid Mechanics**	3	1	0	30	20	50	100	150	4
4	EME - 301	Material Science in Engineering	3	1	0	30	20	50	100	150	4
5	EME - 302	Strength of Materials	3	1	0	30	20	50	100	150	4
6	EME - 303	Thermodynamics	2	1	0	15	10	25	50	75	3
7	EHU - 111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	
PRACTICAL/TRAINING/PROJECT											
8	EME - 351	Material Science & Testing Lab	0	0	2	10	10	20	30	50	1
9	EME - 352	Machine Drawing-I	0	0	3	10	10	20	30	50	1
10	EME - 353	Thermodynamics Lab*	0	0	2	10	10	20	30	50	1
11	ECE - 351	Electrical Machines & Automatic Control lab	0	0	2	10	10	20	30	50	1
12	GP 501	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	18	5	9	-	-	-	-	1000	26

NOTE: Up to IV semesters – common to Mechanical and related branches (such as Production, Industrial, Manufacturing, Automobile, Aeronautical etc.).

Paper Code Science Based Open-Electives

EOE-031/EOE-041	Introduction to Soft Computing (Neural Networks, Fuzzy Logic and Genetic Algorithm)
EOE-032/EOE-042	Nano Sciences
EOE-033/EOE-043	Laser System and Applications
EOE-034/EOE-044	Space Science
EOE-035/EOE-045	Polymer Science & Technology
EOE-036/EOE-046	Nuclear Science
EOE-037/EOE-047	Materials Science
EOE-038/EOE-048	Discrete Mathematics

**Common to Civil Engg. and Mechanical Engg & related branches (as Engineering Core – Interdisciplinary).

*Human values & Professional Ethics will be offered as a compulsory audit course for which passing marks are 40% in theory & 50% in aggregate. Students will be required to audit it with in the period of their study. There will not carry over facility for this course and the failure student will be required to repeat this course (in next-semester).

Note : Mechanical Engineering & related branches students cannot take the Open Elective Course EOE-037/EOE-047: Materials Science.

U.P. TECHNICAL UNIVERSITY, LUCKNOW

STUDY & EVALUATION SCHEME

B. Tech. Mechanical Engineering / Production Engineering / Industrial & Production Engineering / Mechanical & Industrial Engineering / Manufacturing Technology / Automobile Engineering / Aeronautical Engineering

[Effective from Session 2009-10]

YEAR II, SEMESTER-IV

S. No	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						CT	TA	Total			
THEORY											
1	EHU - 402/ EHU - 401	Industrial Sociology/ industrial Psychology	2	0	0	15	10	25	50	75	2
2	EOE 041 - EOE 048 / EAS - 401	Science Based open elective*** /Mathematics III	3	1	0	30	20	50	100	150	4
3	EEE - 409	Electrical Machines & Automatic Control	3	1	0	30	20	50	100	150	4
4	EME - 401	Applied Thermodynamics	3	1	0	30	20	50	100	150	4
5	EME - 402	Manufacturing science-I	3	1	0	30	20	50	100	150	4
6	EME - 403	Measurement & Metrology	2	1	0	15	10	25	50	75	
7	EHU - 111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	
PRACTICAL/TRAINING/PROJECT											
8	EME - 451	Machine Drawing-II	0	0	3	10	10	20	30	50	1
9	EME - 452	Manufacturing science-I Lab	0	0	3	10	10	20	30	50	1
10	EME - 453	Measurement & Metrology Lab	0	0	2	10	10	20	30	50	1
11	EEE - 459	Fluid Machine Lab	0	0	2	10	10	20	30	50	1
12	GP 501	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	18	5	10	-	-	-	-	1000	26
		Industrial Training-I of 4 weeks after IV semester or Minor fabrication project involving work for nearly 4 weeks , which will be evaluated in VII semester									

NOTE: Practical summer training-I of 4-weeks after IV –semester or Minor fabrication project will be evaluated in VII semester

U.P. TECHNICAL UNIVERSITY, LUCKNOW
STUDY & EVALUATION SCHEME

Modified Structure

B. Tech Automobile Engineering
 [Effective from Session 20010-11]
 YEAR III, SEMESTER-V

S.No	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						CT	TA	Total			
THEORY											
1	EHU - 501	Engineering and managerial economics	3	1	0	30	20	50	100	150	3
2	EME - 501	Machine Design-I	2	1	0	15	10	25	50	75	3
3	EAU - 501	Theory of machines	3	1	0	30	20	50	100	150	4
4	EME - 505	IC engines and Compressors	2	1	0	15	10	25	50	75	3
5	EME - 504	Heat and Mass transfer	3	1	0	30	20	50	100	150	4
6	EME - 503	Manufacturing science-II	3	1	0	30	20	50	100	150	4
7	EHU - 111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	
PRACTICAL/TRAINING/PROJECT											
8	EME - 551	Machine Design Lab	0	0	2	10	10	20	30	50	1
9	EAU - 551	Theory of machines Lab	0	0	2	10	10	20	30	50	1
10	EME - 553	Manufacturing science-II Lab	0	0	3	10	10	20	30	50	1
11	EME - 554	Heat and Mass transfer Lab	0	0	3	10	10	20	30	50	1
12	GP 501	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	17	6	10	-	-	-	-	1000	26

*Human values & Professional Ethics will be offered as a compulsory audit course for which passing marks are 40% in theory & 50% in aggregate. Students will be required to audit it with in the period of their study. There will not carry over facility for this course and the failure students will be required to repeat the course (in next semester)

U.P. TECHNICAL UNIVERSITY, LUCKNOW

STUDY & EVALUATION SCHEME

B. Tech. Automobile Engineering

[Effective from Session 2010-11]

YEAR III, SEMESTER-VI

Modified Structure

S. No	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						CT	TA	Total			
THEORY											
1	EHU - 601	Industrial Management	3	1	0	30	20	50	100	150	4
2	EAU 011 - 013	Department elective I	3	1	0	30	20	50	100	150	4
3	EAU-021- 023	Department elective II	3	1	0	30	20	50	100	150	4
4	EAU 602	Automotive fuels and lubricants	3	1	0	30	20	50	100	150	4
5	EAU 603	Design of automotive components	3	1	0	30	20	50	100	150	4
6	EHU - 111	*Human Values & Professional Ethics	2	0	0	15	10	25	50	75	
PRACTICAL/TRAINING/PROJECT											
7	EAU - 653	Design of automotive components Lab	0	0	3	10	10	20	30	50	2
8	EAU 652	Auto fuel and lubrication lab	0	0	2	10	10	20	30	50	1
9	EAU 651	IC engine and automobile lab	0	0	3	10	10	20	30	50	1
10	EAU 654	Seminar	0	0	2	10	10	50	30	50	1
11	GP 301	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	17	6	10	-	-	-	-	1000	26
		Industrial Training-II of 4 – 6 weeks after VI semester will be evaluated in VII semester									

Note- 4 to 6 Weeks Industrial Training-II after VI semester also to be evaluated in VII semester

*Human values & Professional Ethics will be offered as a compulsory audit course for which passing marks are 40% in theory & 50% in aggregate. Students will be required to audit it with in the period of their study. There will not carry over facility for this course and the failure students will be required to repeat the course (in next semester)

Departmental Electives:

Department Elective - I

1. EAU-011 Automotive chassis and suspension
2. EAU-012 Tribology
3. EAU-013 Robotics and Automation

Department Elective - II

1. EAU-021 Vehicle transport management
2. EAU-022 Automotive electrical and autotronics
3. EAU-023 Product design and assembly automation

U.P. TECHNICAL UNIVERSITY, LUCKNOW
STUDY & EVALUATION SCHEME

B. Tech. Automobile Engineering
[Effective from Session 20011-12]
YEAR IV, SEMESTER-VII

S.No	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						CT	TA	Total			
THEORY											
1	EOE 071- EOE 074	Open Elective – I**	3	1	0	30	20	50	100	150	4
2	EAU 031 - 033	Department elective III	3	1	0	30	20	50	100	150	4
3	EAU 041 - 043	Department elective IV	3	1	0	30	20	50	100	150	4
4	EAU 701	Computer Aided Design and Manufacturing	3	1	0	30	20	50	100	150	4
5	EAU 702	Automotive Pollution & Control	3	1	0	30	20	50	100	150	4
6	EHU 111	*Human Values and professional ethics	2	0	0	30	10	25	50	75	
PRACTICAL/TRAINING/PROJECT											
7	EAU - 751	CAD/CAM Lab	0	0	3	10	10	20	30	50	1
8	EAU - 752	Automotive Pollution & Control Lab	0	0	3	10	10	20	30	50	1
9	EAU - 753	Project	0	0	3	10	10	20	30	50	2
10	EAU - 754	Industrial training/Viva voice	0	0	2	10	10	50	30	50	1
11	GP 301	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	15	5	11	-	-	-	-	1000	26

Note- ***Practical Training-1 & 2 (4-weeks each) done after 4th & 6th Semesters would be evaluated in 7th semester through report and viva voice etc.

* Project should be initiated in 7th semester beginning, and should be completed by the end of 8th semester with good Report and power-point Presentation etc.

Paper Code Open Electives – I

EOE-071 Entrepreneurship Development
EOE-072 Quality Management
EOE-073 Operations Research
EOE-074 Introduction to Biotechnology

DEPARTMENTAL ELECTIVES:

Department Elective - III

1. EAU-031 Vehicle body engineering and safety
2. EAU-032 Automotive aerodynamics
3. EAU-033 Optimization for engineering design

Department Elective - IV (Modified)

1. EAU-041 Advanced automobile technologies
2. EAU-042 Automotive air conditioning
3. EAU-043 Interactive computer graphics

U.P. TECHNICAL UNIVERSITY, LUCKNOW
STUDY & EVALUATION SCHEME

Modified Structure

B. Tech. Automobile Engineering
[Effective from Session 20011-12]
YEAR IV, SEMESTER-VIII

S. No	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	Sessional Exam			ESE		
						C	TA	Total			
THEORY											
1	EOE 081 - EOE 084	Open elective – II**	3	1	0	30	20	50	100	150	4
2	EAU 051 - EAU 053	Department elective-V	3	1	0	30	20	50	100	150	4
3	EAU 061 - EAU 063	Department elective-VI	3	1	0	30	20	50	100	150	4
4	EAU 801	Trouble shooting, Servicing & Maintenance of Automobile	3	0	0	30	20	50	100	150	3
5	EHU 851	*Human values and professional ethics	3	0	0	15	10	25	50	75	
PRACTICAL/TRAINING/PROJECT											
6	EAU - 802	Project	0	0	12	-	100	100	250	350	8
7	GP 601	General Proficiency	-	-	-	-	-	50	-	50	1
		Total	17	6	10	-	-	-	-	1000	24

Paper Code Open Electives – II

EOE-081 Non Conventional Energy Resources
EOE-082 Nonlinear Dynamic Systems
EOE-083 Product Development
EOE-084 Automation and Robotics

DEPARTMENTAL ELECTIVES:

Department Elective-V

1. EME-051 Computer aided vehicle design
2. EME-052 Alternative energy sources for automobiles
3. EME-053 Vehicle dynamics

Department Elective-VI

1. EME-061 Computer simulation of IC engines
2. EME-062 Finite Element Method
3. EME-063 Hydraulic and pneumatic systems

EAS-301/EAS-401: MATHEMATICS –III

L T P
3 1 0

Unit – I : Function of Complex variable

Analytic function, C-R equations, Cauchy's integral theorem, Cauchy's integral formula for derivatives of analytic function, Taylor's and Laurent's series, singularities, Residue theorem, Evaluation of real integrals of the type $\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta$ and $\int_{-\infty}^{\infty} f(x) dx$. 10

Unit – II : Statistical Techniques - I

Moments, Moment generating functions, Skewness, Kurtosis, Curve fitting, Method of least squares, Fitting of straight lines, Polynomials, Exponential curves etc., Correlation, Linear, non-linear and multiple regression analysis, Probability theory. 08

Unit – III : Statistical Techniques - II

Binomial, Poisson and Normal distributions, Sampling theory (small and large), Tests of significations: Chi-square test, t-test, Analysis of variance (one way) , Application to engineering, medicine, agriculture etc.

Time series and forecasting (moving and semi-averages), Statistical quality control methods, Control charts, , R, p, np, and c charts. 08

Unit – IV : Numerical Techniques – I

Zeros of transcendental and polynomial equation using Bisection method, Regula-falsi method and Newton-Raphson method, Rate of convergence of above methods.

Interpolation: Finite differences, difference tables, Newton's forward and backward interpolation , Lagrange's and Newton's divided difference formula for unequal intervals. 08

Unit – V : Numerical Techniques –II

Solution of system of linear equations, Gauss- Seidal method, Crout method. Numerical differentiation, Numerical integration , Trapezoidal , Simpson's one third and three-eighth rules, Solution of ordinary differential (first order, second order and simultaneous) equations by Euler's, Picard's and forth-order Runge- Kutta mehtods. 08

Test Books :-

1. Peter V. O'Neil, Advance Engineering Mathematics Thomson (Cengage) Learning, 2007.
2. Jain, Iyenger & Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, New Delhi , 2003.
3. J.N. Kapur, Mathematical Statistics, S. Chand & company Ltd.,2000

Reference Books :-

1. R.K. Jain & S.R.K. Iyenger, Advance Engineering Mathematics, Narosa Publication House, 2002.
2. Chandrika Prasad, Advanced Mathematics for Engineers, Prasad Mudralaya, 1996.
3. E. Kreysig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.
5. Devi Prasad, An introduction to Numerical Analysis, Narosa Publication house, New Delhi 2006.
6. T. Veerajan & T. Ramchandrandran, Theory & Problems in Numerical Methods, TMH, New Delhi, 2004.
7. S.P.Gupta, Statistical Methods, Sultan and Sons, New Delhi, 2004.
8. Devore, Probability and Statistics, Thomson(Cengage) Learning, 2007.

9. Walpole, Myers, Myers & Ye, Probability and Statistics for Engineers & Scientists, Pearson Education, 2003.

ECE-301: FLUID MECHANICS

L T P
3 1 0

I Introduction :

Fluid and continuum, Physical properties of fluids, Rheology of fluids.

II Kinematics of Fluid flow :

Types of fluid flows: Continuum & free molecular flows. Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential, source, sink, doublet and half-body.

III Fluid Statics :

Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about an axis.

IV Dynamics of Fluid Flow :

Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, orifice meter, venturi meter and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends.

V Dimensional Analysis and Hydraulic Similitude :

Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their significance, geometric, kinematics and dynamic similarity, model studies.

VI Laminar and Turbulent Flow :

Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems and networks.

VII Boundary Layer Analysis :

Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sublayer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aerofoil, Magnus effect.

References :

1. S Narasimhan : First Course in Fluid Mechanics , University Press
2. Som, S.K. & Biswas G. : Introduction of fluid mechanics & Fluid Machines, TMH, 2000, 2nd edition.
3. M M Das : Fluid Mechanics & Turbomachines , Oxford University Press
4. S.K.Agarwal : Fluid Mechanics & Machinery, TMH
5. Garde, R.J., " Fluid Mechanics through Problems", New Age International Pvt. Ltd, New Delhi, 2nd Edition.
6. Hunter Rouse, "Elementary Mechanics of Fluids", John Wiley & Sons. Omc. 1946
7. I.H.Shames, "Mechanics of Fluids", McGraw Hill, Int. Student, Education, 1988.
8. Fluid Mechanics by Jagdish Lal
9. Vijay Gupta and S.K.Gupta, " Fluid Mechanics and its Applications", Wiley Eastern Ltd, 1984.
10. Modi, P.N., and Seth, S.H., "Hydraulics and Fluid Machines", Standard Book House, 1989.

Unit-I

Introduction : Historical perspective, importance of materials. Brief review of modern & atomic concepts in Physics and Chemistry. Atomic models, Periodic table, Chemical bondings. 4

Crystallography and Imperfections : Concept of unit cell space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices. Xray crystallography techniques. Imperfections, Defects & Dislocations in solids. 3

Unit-II

Mechanical properties and Testing : Stress strain diagram, Ductile & brittle material, Stress vs strength. Toughness, Hardness, Fracture, Fatigue and Creep. Testings such as Strength testings, Hardness testing, Impact testings, Fatigue testing Creep testing, Non-destructive testing (NDT) 4

Microstructural Exam : Microscope principle and methods. Preparation of samples and Microstructure exam and grain size determination. Comparative study of microstructure of various metals & alloys such as Mild steel, CI, Brass. 2

Phase Diagram and Equilibrium Diagram : Uniary and Binary diagrams, Phase rules. Types of equilibrium diagrams: Solid solution type, eutectic type and combination type. Iron-carbon equilibrium diagram. 4

Unit-III

Ferrous materials : Brief introduction of iron and steel making furnaces. Various types of carbon steels, alloy steels and cast irons, its properties and uses. 3

Heat Treatment : Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams. 2

Non-Ferrous metals and alloys : Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications. Various type Brass, Bronze, bearing materials, its properties and uses. Aluminum alloys such as Duralumin. Other advanced materials/alloys. 3

Unit-IV

Magnetic properties : Concept of magnetism - Dia, para, ferro Hysteresis. Soft and hard magnetic materials, Magnetic storages. 2

Electric properties : Energy band concept of conductor, insulator and semi-conductor. Intrinsic & extrinsic semi-conductors. P-n junction and transistors. Basic devices and its application. Diffusion of Solid. 3

Super conductivity and its applications. Messier effect. Type I & II superconductors. High Tc superconductors. 2

Unit-V

Ceramics : Structure types and properties and applications of ceramics. Mechanical/Electrical behavior and processing of Ceramics. 2

Plastics : Various types of polymers/plastics and its applications. Mechanical behaviour and processing of plastics. Future of plastics. 2

Other materials : Brief description of other material such as optical and thermal materials concrete, Composite Materials and its uses. Brief introduction to Smartmaterials & Nano-materials and their potential applications 3

Performance of materials in service: Brief theoretical consideration of Fracture, Fatigue, and Corrosion and its control. 2

References :

1. W.D. Callister, Jr, - Material Science & Engineering Addition-Wesley Publication.
2. K.M.Gupta, Materials Science, Umesh Publication.

3. Van Vlash - Elements of Material Science & Engineering John Wiley & Sons.
4. V. Raghvan - Material Science, Prentice Hall.
5. Narula - Material Science, TMH.
6. Srivastava, Srinivasan - Science of Materials Engineering, NewAge Publication.

EME- 302 STRENGTH OF MATERIALS

L T P
3 1 0

UNIT-I

Compound stress and strains: Introduction, state of plane stress, Principal stress and strain, Mohr's stress circle. 3

3-D Stress, Theory of failure, Castiglion's Theorem, Impact load: Threedimensional state of stress & strain, equilibrium equations. Generalized Hook's Law. Theories of Failure. Castigliano's Theorem. Impact load & stresses. 5

UNIT –II

Stresses in Beams: Review of pure Bending. Direct and shear stresses in beams due to transverse and axial loads, composite beams. 2

Deflection of Beams: Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams. 4

Torsion: Review of Torsion, combined bending & torsion of solid & hollow shafts. 2

UNIT-III

Helical and Leaf Springs: deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs. 4

Columns and Struts: Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Ranking Gardon Formulae, Examples of columns in mechanical equipments and machines. 4

UNIT-IV

Thin cylinders & spheres: Hoop and axial stresses and strain. Volumetric strain. 2

Thick cylinders: Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, Compound cylinders. Stresses in rotating shaft and cylinders. Stresses due to interference fits. 6

UNIT-V

Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression. 4

Unsymmetrical Bending: Properties of beam cross-section, slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis(for symmetry about both axis and about one axis) for I-section and channelsection. 4

Books :

1. Mechanics of Materials by Pytel
2. Strength of Materials by Ryder
3. Strength of Materials by Timoshenko and Youngs
4. Mechanics of Materials by Bear Jhonson

EME-303 : THERMODYNAMICS

L T P
2 1 0

Unit – I:

Fundamental Concepts and Definitions: Introduction and definition of thermodynamics, Dimensions and units, Microscopic and Macroscopic approaches, Systems, surroundings and universe, Concept of continuum, Control system boundary, control volume and control surface, Properties and state, Thermodynamic properties, Thermodynamic path, process and cycle, Thermodynamic equilibrium, Reversibility and irreversibility, Quasi static process, Energy and its forms, Work and heat, Gas laws, Ideal gas, Real gas, Law of corresponding states, Dalton's law, Amagat's law, Property of mixture of gases. **3**

Zeroth law of thermodynamics: Zeroth law of thermodynamics, Temperature and its' measurement, Temperature scales. **1**

First law of thermodynamics: Thermodynamic definition of work, Thermodynamic processes, Calculation of work in various processes and sign convention, Non-flow work and flow work, Joules' experiment, First law of thermodynamics, Internal energy and enthalpy, First law of thermodynamics applied to open systems, Steady flow systems and their analysis, Steady flow energy equation, Boilers, Condensers, Turbine, Throttling process, Pumps etc. First law analysis for closed system (non flow processes), Analysis of unsteady processes such as filling and evacuation of vessels with and without heat transfer, Limitations of first law of thermodynamics, PMM-I. **4**

Unit – II:

Second law: Devices converting heat to work, Thermal reservoir, Heat engines, Efficiency, Devices converting work to heat, Heat pump, refrigerator, Coefficient of Performance, Reversed heat engine, Kelvin Planck statement of second law of thermodynamics, Clausius statement of second law of thermodynamics, Equivalence of two statements of second law of thermodynamics, Reversible and irreversible processes, Carnot cycle and Carnot engine, Carnot theorem and its' corollaries, thermodynamic temperature scale, PMM-II. **4**

Unit – III

Entropy : Clausius inequality, Concept of Entropy, Entropy change in different thermodynamic processes, Tds equation, Principle of entropy increase, T-S diagram, Statement of the third law of thermodynamics. **4**

Availability and Irreversibility: Available and unavailable energy, Availability and Irreversibility, Second law efficiency, Helmholtz & Gibb's function. **3**

Unit – IV

Properties of steam and thermodynamics cycles: Pure substance, Property of steam, Triple point, Critical point, Sub-cooled liquid, Saturation states, Superheated states, Phase transformation process of water, Graphical representation of pressure, volume and temperature, P-T & P-V diagrams, T-S and H-S diagrams, use of property diagram, Steam-Tables & Mollier charts, Dryness factor and its' measurement, processes involving steam in closed and open systems. Simple Rankine cycle. **5**

Introduction to working of IC engines: Compression Ignition engines, Spark Ignition engines, 2 stroke and 4 stroke engines, Performance parameters of IC engine, Heat balance sheet. **2**

Books:

1. Engineering Thermodynamics by Jones and Dugans, PHI Learning Pvt. Ltd.
2. Fundamentals of Thermodynamics by Sonntag, Wiley India Pvt. Ltd.
3. Fundamentals of Classical Thermodynamics by Van Wylen, John wiley & sons.

4. Thermodynamics by J.P. Holman, McGraw Hill.
5. Engineering Thermodynamics by P.K.Nag, Tata Mc Graw Hill Pub.
6. Engineering Thermodynamics by Onkar Singh, New Age International Pub..
7. Thermal Engineering By R.K. Rajput, Laxmi Publication.
8. Engineering Thermodynamics by C.P. Arora.

EME- 351 : MATERIALS SCIENCE AND TESTING Labs

**L T P
0 0 3**

(A). Material Science Lab Experiments : (at least 5 of the following)

1. Making a plastic mould for small metallic specimen.
2. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.
3. Grain Size determination of a given specimen.
4. Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
5. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.
6. Material identification of, say, 50 common items kept in a box.
7. Faradays law of electrolysis experiment.
8. Study of corrosion and its effects.
9. Study of microstructure of welded component and HAZ. Macro & Micro Examination.
10. Suitable experiment on Magnetic/ Electrical/Electronic materials.

+

(B). Material Testing Lab Experiments : (at least 5 of the following)

1. Strength testing of a given mild steel specimen on UTM with full details and s-e plot on the machine.
2. Other tests such as shear, bend tests on UTM.
3. Impact testing on impact testing machine like Charpy, Izod or both.
4. Hardness testing of given specimen using Rockwell and Vickers/Brinell testing machines.
5. Spring index testing on spring testing machine.
6. Fatigue testing on fatigue testing machine.
7. Creep testing on creep testing machine.
8. Deflection of beam experiment, comparison of actual measurement of deflection with dial gauge to the calculated one, and or evaluation of young's modulus of beam.
9. Torsion testing of a rod on torsion testing machine.
10. Study of non-destructive testing methods like magnetic flaw detector, ultrasonic flaw detector, eddy current testing machine, dye penetrant tests.

EME – 352: MACHINE DRAWING-I LAB

**L T P
0 0 3**

Introduction (1 drawing sheet)

Graphics Language, Classification of drawings, Principles of drawing, IS codes for machine drawing, scales, types of lines, section lines, Dimensioning **2**

Orthographic Projections (1 drawing sheet)

Principle of first angle and third angle projection, drawing of machine elements in first angle projection, selection of views, sectional views **2**

Screwed fasteners (2 drawing sheet)

Thread nomenclature, Forms of thread, Thread series, designation, Representation of threads, Bolted joints, Locking arrangement of nuts **2**

Keys and Cotter and Pin joint (1 drawing sheet) **2**

Types of keys, Cotter joint or Knuckle joint

Shaft Couplings (1 drawing sheet) **2**

Introduction, Rigid coupling or Flexible coupling

Riveted joints (1 drawing sheet)

Introduction, rivets and riveting, Types of rivet heads, Types of riveted joints, Boiler joint **1**

Assembly Drawing (1 drawing sheet)

Introduction, Engine parts-stuffing box, cross head **1**

Free hand sketching*

Introduction, Need for free hand sketching, Free hand sketching of foundation bolts, studs, pulleys, couplings etc.

* students may be asked to submit the free hand sketching assignment at the end of the semester

Books and References:

1. Machine Drawing-KL Narayana, P Kannaiah, KV Reddy-New Age
2. Machine Drawing-PS Gill-SK Kataria & sons
3. Machine Drawing-N. Siddeshwar, P Kannaiah, VVS Shastry, Tata McGraw Hill
4. Engineering drawing Practice for School and Colleges, SP46-1988 (BIS)

EME-353 : THERMODYNAMICS LAB**L T P
0 0 2**

Experiments : Minimum 10 experiments out of following;

1. Study of Fire Tube boiler
2. Study of Water Tube boiler
3. Study and working of Two stroke petrol Engine
4. Study and working of Four stroke petrol Engine
5. Determination of Indicated H.P. of I.C. Engine by Morse Test
6. Prepare the heat balance for Diesel Engine test rig
7. Prepare the heat balance sheet for Petrol Engine test rig
8. Study and working of two stroke Diesel Engine
9. Study and working of four stroke Diesel Engine.
10. Study of Velocity compounded steam turbine
11. Study of Pressure compounded steam turbine
12. Study of Impulse & Reaction turbine
13. Study of steam Engine model.
14. Study of Gas Turbine Model
15. Any other suitable experiment on thermodynamics

ECE-351 : Fluid Mechanics Lab**L T P
0 0 2**

1. To verify the momentum equation using the experimental set-up on diffusion of submerged air jet.
2. To determine the coefficient of discharge of an orifice of a given shape. Also to determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter, venturimeter, and bend meter and study the variation of the coefficient of discharge with the Reynolds number.
4. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
5. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
6. To study the variation of friction factor, 'f' for turbulent flow in commercial pipes.
7. To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.

EEE – 409 : ELECTRICAL MACHINES & AUTOMATIC CONTROL**L T P
3 1 0****UNIT I:**

Single phase Transformer: Efficiency Voltage regulation, O.C.& S.C. Tests. **2**

Three Phase Transformer: Three phase transformer connections, 3-phase to 2-phase or 6-phase connections and their applications. **2**

Auto Transformer: Volt- Amp relations, efficiency, advantages & disadvantages, applications. **1**

D.C. Motors: Concept of starting, speed control, losses and efficiency. **3**

UNIT II:

Three phase Induction Motor: Construction, equivalent circuit, torque equation and torque-slip characteristics, speed control. 3

Alternator: Construction, e.m.f. equation, Voltage regulation and its determination by synchronous impedance method. 3

Synchronous Motor: Starting, effect of excitation on line current (V-curves), synchronous condenser. 2

Servo Motor: Two phase a.c. servo motor & its application. 1

UNIT III:

Modeling of Mechanical System: linear mechanical elements, force-voltage and force current analogy, electrical analog of simple mechanical systems; concept of transfer function & its determination for simple systems. 4

Control System: Open loop & closed loop controls, servo mechanisms; concept of various types of system. 2

Signals: Unit step, unit ramp, unit impulse and periodic signals with their mathematical representation and characteristics. 1

UNIT IV:

Time Response Analysis: Time response of a standard second order system and response specifications, steady state errors and error constants. 2

Stability: Concept and types of stability, Routh Hurwitz Criterion and its application for determination of stability, limitations; Polar plot, Nyquist stability Criterion and assessment of stability. 6

UNIT V:

Root Locus Techniques: Concept of root locus, construction of root loci.

Frequency Response Analysis: Correlation between time and frequency responses of a second order system; Bode plot, gain margin and phase margin and their determination from Bode and Polar plots. 4

Process control: Introduction to P,PI and PID controllers their characteristics, representation and applications. 1

Text Book:

1. I. J. Nagrath & D. P. Kothari, "Electrical machines" Tata McGraw Hill.
2. B.R. Gupta & Vandana Singhal, "Fundamentals of Electrical Machines", New Age International.
3. K. Ogata, "Modern Control Engineering" Prentice Hall of India.
4. B.C. Kuo, "Automatic Control systems." Wiley India Ltd.

Reference Books:

5. Irvin L. Kosow, "Electric Machinery and Transformers" Prentice Hall of India.
6. D. Roy Choudhary, "Modern Control Engineering" Prentice Hall of India.
7. M. Gopal, Control Systems: Principles and Design" Tata McGraw Hill.

EME-401 APPLIED THERMODYNAMICS

L T P

3 1 0

Unit-I

Thermodynamic relations: Mathematical conditions for exact differentials. Maxwell Relations, Clapeyron Equation, Joule-Thompson coefficient and Inversion curve. Coefficient of volume expansion, Adiabatic & Isothermal compressibility. 3

Fuels and Combustion: Combustion analysis, Heating Values, Air requirement, Air/Fuel ratio, Standard heat of Reaction and effect of temperature on standard heat of reaction, heat of formation, Adiabatic flame temperature. 4

Unit-II

Boilers: Steam generators-classifications. Working of fire-tube and water-tube boilers, boiler mountings & accessories, Draught & its calculations, air pre heater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance. **6**

Condenser: Classification of condenser, Air leakage, Condenser performance parameters **2**

Unit-III

Steam Engines: Rankine and modified Rankine cycles, Working of steam engine, Classification of steam engines, Indicator diagram, Saturation curve, Missing quantity, Heat balance. **3**

Steam & Gas Nozzles: Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, Super saturated flow. **4**

Unit-IV

Vapour Power cycles: Carnot vapour power cycle, Effect of pressure & temperature on Rankine cycle, Reheat cycle, Regenerative cycle, Feed water heaters, Binary vapour cycle, Combined cycles, Cogeneration. **3**

Steam Turbines : Classification of steam turbine, Impulse and reaction turbines, Staging, Stage and overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple & compound multistage impulse & reaction turbines & related calculations work done efficiencies of reaction, Impulse reaction Turbines, state point locus, Comparison with steam engines, Losses in steam turbines, Governing of turbines. **4**

Unit-V

Gas Turbine: Gas turbine classification Brayton cycle, Principles of gas turbine, Gas turbine cycles with intercooling, reheat and regeneration and their combinations, Stage efficiency, Polytropic efficiency. Deviation of actual cycles from ideal cycles. **4**

Jet Propulsion: Introduction to the principles of jet propulsion, Turbojet and turboprop engines & their processes, Principle of rocket propulsion, Introduction to Rocket Engine. **3**

Books:

1. Applied thermodynamics by Onkar Singh, New Age International (P) Publishers Ltd.
2. Basic and Applied Thermodynamics by P.K. Nag, Tata Mc Graw Hill Pub.
3. Thermal Engg. By P.L. Ballaney, Khanna Publisher
4. Theory of Steam Turbine by W.J. Kearton
5. Steam & Gas Turbine by R.Yadav, CPH Allahabad
6. Thermal Engg. By R.K. Rajput, Laxmi Publication
7. Gas Turbine, by V. Ganeshan, Tata Mc Graw Hill Publishers.
8. Gas turbine Theory & Practice, by Cohen & Rogers, Addison Wesley Long man

EME- 402 : MANUFACTURING SCIENCE-I **L T P**
3 1 0

Unit-I

Introduction :

Importance of manufacturing. Economic & technological considerations in manufacturing. Classification of manufacturing processes. Materials & manufacturing processes for common items. **2**

Metal Forming Processes :

Elastic & plastic deformation, yield criteria. Hot working vs cold working. **2**

Analysis (equilibrium equation method) of Forging process for load estimation with sliding friction sticking friction and mixed condition for slab and disc. Work required for forging, Hand, Power, Drop Forging **5**

Unit-II

Metal Forming Processes (continued): Analysis of Wire/strip drawing and maximum-reduction, Tube drawing, Extrusion and its application.	3
Condition for Rolling force and power in rolling. Rolling mills & rolled-sections.	2
Design, lubrication and defects in metal forming processes.	2

Unit-III

Sheet Metal working :

Presses and their classification, Die & punch assembly and press work methods and processes. Cutting/Punching mechanism, Blanking vs Piercing. Compound vs Progressive die. Flat-face vs Inclined-face punch and Load(capacity) needed.	4
Analysis of forming process like cup/deep drawing. Bending & spring-back.	3

Unit-IV

Unconventional Metal forming processes :

Unconventional metal forming processes such as explosive forming, electromagnetic, electro-hydraulic forming.	2
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Powder Metallurgy :

Powder metallurgy manufacturing process. The need, process, advantage and applications.	2
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Jigs & Fixtures :

Locating & Clamping devices & principles. Jigs and Fixtures and its applications.	2
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Manufacturing of Plastic components :

Review of plastics, and its past, present & future uses. Injection moulding. Extrusion of plastic section. Welding of plastics. Future of plastic & its applications. Resins & Adhesives.	2
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Unit-V

Casting (Foundry)

Basic principle & survey of casting processes. Types of patterns and allowances. Types and properties of moulding sand. Elements of mould and design considerations, Gating, Riser, Runnes, Core. Solidification of casting,. Sand casting, defects & remedies and inspection. Cupola furnace.	7
Die Casting, Centrifugal casting. Investment casting, CO ₂ casting and Stir casting etc.	3

Books :

1. Manufacturing Science by Ghosh and Mallik
2. Production Engg. Science by P.C. Pandey
3. Production Technology by R.K. Jain
4. Manufacturing Technology by P.N. Rao., TMH
5. Materials and Manufacturing by Paul Degarmo.
6. Manufacturing Science by KM Moeed.
7. Manufacturing Engineering & Technology by Kalpakjian, Pearson Pub.

EME -403 : MEASUREMENT AND METROLOGY

L T P
2 1 0

Unit-I

Mechanical Measurements

Introduction: Introduction to measurement and measuring instruments, Generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration, concept of error, sources of error, statistical analysis of errors.	4
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Sensors and Transducers:

Types of sensors, types of transducers and their characteristics.	2
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Signal transmission and processing:

Devices and systems.	2
Signal Display & Recording Devices	1

Unit-II

Time related measurements:	
Counters, stroboscope, frequency measurement by direct comparison.	1
Measurement of displacement	1
Measurement of pressure:	
Gravitational, directing acting, elastic and indirect type pressure transducers. Measurement of very low pressures.	1
Strain measurement:	
Types of strain gauges and their working, strain gauge circuits, temperature compensation. Strain rosettes, calibration.	2
Measurements of force and torque:	
Different types of load cells, elastic transducers, pneumatic & hydraulic systems.	1
Temperature measurement:	
Thermometers, bimetallic thermocouples, thermistors and pyrometers.	2
Vibration:	
Seismic instruments, vibration pick ups and decibel meters, vibrometers accelerometers.	2

Unit-III:

Metrology

Metrology and Inspection :

Standards of linear measurement, line and end standards. Limit fits and tolerances. Interchangeability and standardisation.	2
Linear and angular measurements devices and systems Comparators: Sigma, Johansson's Microkrator.	2
Limit gauges classification, Taylor's Principle of Gauge Design.	1

Unit-IV

Measurement of geometric forms like straightness, flatness, roundness.	2
Tool makers microscope, profile project autocollimator.	1
Interferometry: principle and use of interferometry, optical flat.	2
Measurement of screw threads and gears.	1
Surface texture: quantitative evaluation of surface roughness and its measurement.	1

Measurement and Inspection: Dimensional inspection – Tolerance, Limit gauging, comparators, Surface roughness, Feature inspection.

References

1. Beckwith Thomas G., Mechanical Measurements, Narosa Publishing House, N. Delhi.
2. Doeblein E.O., "Measurement Systems, Application Design", McGraw Hill, 1990.
3. Kumar D.S., "Mechanical Measurements and Control", Metropolitan, N. Delhi.
4. Hume K.J., "Engineering Metrology", MacDonal and Co. 1963
5. Gupta, I.C., "Engineering Metrology", Dhanpat Rai & Sons, New Delhi, 1994
6. Sirohi, "Mechanical Measurement" New Age Publishers
7. Jain, R.K., "Engineering Metrology" Khanna Publishers
8. Jain, R.K., "Mechanical Measurement" Khanna Publishers

EME – 451 : MACHINE DRAWING-II LAB

L T P

0 0 3

Review of Orthographic Projections (1 drawing sheet)

Orthographic Projection of solids in First angle of projection, missing lines views, interpretation of views

2

Part and Assembly Drawing (2 drawing sheet)

Assembly drawing of eccentric, lathe tail stock, air valve, screw jack, connecting rod, safety valve etc.

2

Specification of Materials (1 drawing sheet)

Engineering materials, representation, Code designation of steel, copper, aluminium etc.

Limits, Tolerance and Fits (1 drawing sheet)

Limit system, Tolerances, Method of placing limit dimensions, Fits-types

2

Surface Roughness (1 drawing sheet)

Introduction, nomenclature, machining symbols, indication of surface roughness

1

Production Drawing (1 drawing sheet)

Types, Examples of simple machine elements like helical gear, bevel gear, crank, connecting rod, belt pulley, piston etc. 2

Computer Aided Drafting (2 drawings)

Introduction, input, output devices, introduction to software like AutoCAD, ProE, basic commands and development of 2D and 3D drawings of simple parts 3

Books and References:

1. Machine Drawing - KL Narayana, P Kannaiah, KV Reddy - New Age
2. Machine Drawing - PS Gill - SK Kataria & sons
3. Machine Drawing -N. Siddeshwar, P Kannaiah, VVS Shastry -Tata McGraw Hill
4. Engineering Drawing - RK Dhawan - S. Chand
5. AutoCAD-S. Vshal - Dhanpat Rai
6. Engineering Graphics - BK Goel & PK Goel - SK Kataria
7. Computer Aided Engineering Graphics - Rajashekhar Patil - New Age
8. Engineering Drawing - Dhananjay A Jolhe - Tata McGraw Hill
9. Engineering Drawing - CM Agrawal - Tata McGraw Hill
10. Machine Drawing – Ajeet Singh – The Mc Graw Hill Companies

EME-452 : MANUFACTURING SCIENCE-1 LAB

**L T P
0 0 3**

Experiments :

Say minimum 8 experiments out of following (or such experiment).

1. Design of pattern for a desired casting (containing hole)
2. Pattern making
3. Making a mould (with core) and casting.
4. Sand testings (at least one such as grain fineness number determination)
5. Injection moulding with plastics
6. Forging hand forging processes
7. Forging - power hammer study & operation
8. Tube bending with the use of sand and on tube bending m/c.
9. Press work experiment such as blanking/piercing, washer, making etc.
10. Wire drawing/extrusion on soft material.
11. Rolling-experiment.
12. Bending & spring back.
13. Powder metallurgy experiment.
14. Jigs & Fixture experiment.
15. Any other suitable experiment on manufacturing science / process / technique.

EME 453: MEASUREMENT & METROLOGY LAB

**L T P
0 0 2**

Experiments: Minimum 8 out of following (or such experiments)

1. Study & working of simple measuring instruments- Vernier calipers, micrometer, tachometer.
2. Measurement of effective diameter of a screw thread using 3 wire method.
3. Measurement of angle using sinebar & slip gauges. Study of limit gauges.
4. Study & angular measurement using level protector
5. Adjustment of spark plug gap using feeler gauges.
6. Study of dial indicator & its constructional details.
7. Use of dial indicator to check a shape run use.
8. Study and understanding of limits, fits & tolerances
9. Study of Pressure & Temperature measuring equipment.
10. Strain gauge measurement.
11. Speed measurement using stroboscope.
12. Flow measurement experiment

13. Vibration/work measuring experiment.
14. Experiment on Dynamometers.

EEE – 459 : ELECTRICAL MACHINES & AUTOMATIC CONTROL LAB

**L T P
0 0 2**

Note: To perform at least 7 experiments of Electrical Machines and 3 experiments of Automatic Control System

A. Electrical Machines

1. To obtain speed-torque characteristics and efficiency of a dc shunt motor by direct loading.
2. To obtain efficiency of a dc shunt machine by no load test.
3. To obtain speed control of dc shunt motor using (a) armature voltage control (b) field control.
4. To determine polarity and voltage ratio of single phase and three phase transformers.
5. To obtain efficiency and voltage regulation by performing O.C. and S.C. tests on a single phase transformer at full load and 0.8 p.f. loading.
6. To obtain 3-phase to 2-phase conversion using Scott connection.
7. To perform load test on a 3-phase induction motor and determine (a) speed- torque characteristics (ii) power factor v/s line current characteristics.
8. To study speed control of a 3-phase induction motor using (a) Voltage Control (b) Constant (Voltage/ frequency) control.
9. To perform open circuit and short circuit test on a 3-phase synchronous machine and determine voltage regulation at full load and unity, 0.8 lagging and 0.8 leading power factor using synchronous impedance method.
10. To determine V-curve of a 3-phase synchronous motor at no load, half load and full load.

B. Automatic Control System:

1. To determine transient response of a second order system for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To determine speed – torque characteristics of an a.c. 2-phase servo motor.
4. To study and calibrate temperature using Resistance Temperature Detector(RTD)
5. To study dc servo position control system within P and PI configurations.
6. To study synchro transmitter and receiver system and determine output V/s input characteristics.
7. To study open loop and closed loop control of a dc separately excited motor.

EME-501 : MACHINE DESIGN-I

**L T P
2 1 0**

UNIT I

Introduction

Definition, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon & alloy steels, Selection of materials for static and fatigue loads **3**

Design against Static Load

Modes of failure, Factor of safety, Principal stresses, Stresses due to bending and torsion, Theory of failure **4**

UNIT II

Design against Fluctuating Loads

Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria **4**

Riveted Joints-Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint **4**

UNIT III

Shafts

Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity **4**

Keys and Couplings

Types of keys, splines, Selection of square & flat keys, Strength of sunk key, Couplings- Design of rigid and flexible couplings **4**

UNIT IV

Mechanical Springs

Types, Material for helical springs, End connections for compression and tension helical springs, Stresses and deflection of helical springs of circular wire, Design of helical springs subjected to static and fatigue loading **4**

Power Screws

Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack **3**

Note: Design data book is allowed in the examination

Books and References:

1. Mechanical Engineering Design – Joseph E. Shigely, McGraw Hill Publications
2. Design of Machine Memembers-Alex Valance and VI Doughtie, McGraw Hill Co.
3. Machine design-M.F. Spott, Prentice Hall India
4. Machine Design-Maleev and Hartman, CBS
5. Machine design -Black & Adams, Mc Graw Hill
6. Machine Design-Sharma and Agrawal, S.K. Katara & Sons
7. Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Co.

EAU 501 : THEORY OF MACHINES

L T P

3 1 0

Objective: To expose students to different mechanisms, their methods of working, forces involved. & their balancing.

Unit I

Introduction:

Mechanism and machines, Kinematic links, Kinematic pairs, Kinematic chains, plane and space mechanism. kinematic inversion, equivalent linkages, four link planer & slider crank mechanisms, mobility and range of movement, straight line mechanisms, steering mechanisms, pantograph, problems.

Unit II

Kinematic Analysis or Plane Mechanisms

Displacement analysis, general plane motion, instantaneous center of velocity, graphical and analytical methods of velocity and acceleration analysis, problems.

Unit III

Gearing & Cams

Fundamental law of gearing, involute spur gears, characteristics of involute action, Interference and undercutting, center distance variation, non standard gear teeth, helical, spiral, bevel and worm gears, problems. Types of cams - Design profiles-knife edged, flat faced & roller ended followers with & without offsets for various types of follower motions, problems.

Unit IV

Static and Dynamic Force Analysis

Static force analysis of planer mechanisms, dynamic force analysis including inertia and frictional forces of planer mechanisms.

Unit V

Dynamics of Reciprocating Engines

Engine types, indicator diagrams, gas forces equivalent masses, inertia forces, bearing loads in a single cylinder engine, crankshaft torque, engine shaking forces.

Unit VI

Balancing of Rotating Components

Static balance, dynamic balance, balancing of rotating masses, two plane balancing, graphical and analytical methods, balancing of rotors, balancing machines, field balancing.

Unit VII

Balancing of Reciprocating Parts

Balancing of single cylinder engine, balancing of multi cylinder-inline, radial and V type engines, firing orders.

Unit VIII

Gyroscope

Gyroscopes, gyroscopic forces and couples, gyroscopic stabilization, stability of four wheel and two wheel vehicles moving on curved paths.

Text Books

1. Theory of Mechanisms and Machines by Amitabha Ghosh and As'hok Kumar Mallik. 3rd Edition affiliated East-West Press.
2. Theory of Machines and Mechanisms by Joseph Edward Shigley and John Joseph, Uicher, Jr, Second Edition McGraw Hill, Inc.

Ref. Books

1. Mechanism and Machine Theory by J.S. Rao and RV. Oukkipati, New age International.
2. Theory and Machine (S I Units) by S.S. Rattan, Tata McGrawHill
3. Theory of machines by Abdulla Sharif
4. Theory of machines by Ballaney, Pandya & Shah,

EME-503 : MANUFACTURING SCIENCE-II

L T P
3 1 0

Unit-I

A Metal Cutting and Machine Tools

Metal Cutting-

Mechanics of metal cutting. Geometry of tool and nomenclature .ASA system Orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Dynamometer. Brief introduction to machine tool vibration and surface finish. Economics of metal cutting. **9**

Unit-II

Machine Tools

- (i) Lathe : Principle, construction, types, operations, Turret/capstan, semi/Automatic, Tool layout. **2**
- (ii) Shaper, slotter, planer : Construction, operations & drives. **1**
- (iii) Milling : Construction, Milling cutters, up & down milling. Dividing head & indexing. Max chip thickness & power required. **2**
- (iv) Drilling and boring : Drilling, boring, reaming tools. Geometry of twist drills. **2**

Unit-III

Grinding & Super finishing

- (v) Grinding : Grinding wheels, abrasive & bonds, cutting action. Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing.

Max chip thickness and Guest criteria. Surface and Cylindrical grinding. Centerless grinding.	4
(vi) Super finishing : Honing, lapping, polishing.	1
Standardization & Interchangeability, Limits, Fits & Tolerance and Surface roughness:	
Introduction to Standardization & Interchangeability Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness.	3

Unit-IV

B. Metal Joining (Welding)

Survey of welding and allied processes. Gas welding and cutting, process and equipment. Arc welding : Power sources and consumables. TIG & MIG processes and their parameters. Resistance welding - spot, seam projection etc. Other welding processes such as atomic hydrogen, submerged arc, electroslag, friction welding. Soldering & Brazing.

8

Thermodynamic and Metallurgical aspects in welding and weld, Shrinkage/residual stress in welds. Distortions & Defects in welds and remedies. Weld decay in HAZ.

2

Unit-V

C. Introduction to Un-conventional Machining and Welding

Need & benefits, application and working principle of EDM, ECM, LBM, EBM, USM. AJM, WJM. Similarly, non-conventional welding applications such as LBW, USW, EBW, Plasma-arc welding, Diffusion welding, Explosive welding/cladding.

6

Books

1. Manufacturing science by Ghosh and Mallik
2. Fundamentals of Metal Cutting and Machine tools by Boothroyd
3. Production Technology by R.K. Jain
4. Production Technology - H.M.T.
5. Production Engineering Science by P.C. Pandey
6. Modern Machining Processes by P.C. Pandey & H.S. Shan
7. Manufacturing science by Degarmo
8. Fundamentals of metal cutting & machine tools - Juneja & Shekhon
9. Process & materials of manufacturing - Lindburg.
10. Advanced Machining Process - VK Jain

EME-504 HEAT & MASS TRANSFER

L T P

3 1 0

UNIT-1

Introduction to Heat Transfer:

Concepts of the mechanisms of heat flows; Conduction, convection and radiation; Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism.

2

Conduction :

One-dimensional general differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems; Initial and boundary conditions.

3

Steady State one-dimensional Heat conduction :

Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; Thermal resistance concept; Analogy between heat and electricity flow; Thermal contact resistance; Critical thickness of insulation.

3

UNIT-2

Fins:

Heat transfer from extended surfaces, Fins of uniform cross-sectional area; Errors of measurement of temperature in thermometer wells.

3

Transient Conduction:

Transient heat conduction; Lumped capacitance method; Time constant; Unsteady state heat conduction in one dimension only, Heisler charts.

4

UNIT-3

Forced Convection:

Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Flow across a single cylinder and a sphere; Flow inside ducts; Empirical heat transfer relations; Relation between fluid friction and heat transfer; Liquid metal heat transfer. **4**

Natural Convection :

Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere ; Combined free and forced convection. **3**

UNIT-4

Thermal Radiation :

Basic radiation concepts; Radiation properties of surfaces; Black body radiation Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; ; Gray body; Shape factor; Black-body radiation; Radiation exchange between diffuse non black bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Green house effect. **8**

UNIT-5

Heat Exchanger :

Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers. **3**

Condensation And Boiling :

Introduction to condensation phenomena; Heat transfer relations for laminar film condensation on vertical surfaces and on outside & inside of a horizontal tube; Effect of non-condensable gases; Dropwise condensation; Heat pipes; Boiling modes, pool boiling; Hysteresis in boiling curve; Forced convective boiling. **3**

Introduction To Mass Transfer :

Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion through a stagnant gas film. **2**

Books:

1. Elements of Heat transfer by Bayazitoglu & Ozisik, McGraw-Hill Book Company.
2. Heat Transfer By J.P. Holman, McGraw-Hill International edition.
3. Schaum's outline of Heat Transfer by Pitts & Sisson McGraw-Hill International edition.
4. Principles of Heat Transfer by Frank Kreith, McGraw-Hill Book co.
5. Fundamentals of Momentum, Heat and Mass Transfer by James R.Welty; John Wiley & Sons (Pvt). Ltd.
6. Heat Transfer, by Vijay Gupta, New Age International (P) Ltd. Publishers
7. Heat Transfer, by Y.V.C. Rao, University Press.
8. Heat Transfer, by R. Yadav, Central Publishing House, Allahabad.

EME-505 : I C ENGINES & COMPRESSORS

L T P
2 1 0

Unit-1

Introduction to I.C Engines: Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, Stirling cycle, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, stratified charge engine. **5**

Fuels: Fuels for SI and CI engine , Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines. **3**

Testing and Performance: Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines. 2

Unit-2

SI Engines:

Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and its control, combustion chamber design for SI engines. 2

Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI. 3

Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition. 2

Unit-3

CI Engine:

Combustion in CI engines, Ignition delay, Knock and its control, Combustion chamber design of CI engines. 2

Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings. 3

Scavenging in 2 Stroke engines, pollution and its control. 2

Unit-4

Engine Cooling: Different cooling systems, Radiators and cooling fans. 1

Lubrication: Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation. 2

Supercharging: Effect of altitude on power output, Types of supercharging 1

Compressors:

Classification, Reciprocating compressors, Single and Multi stage compressors, Intercooling, Volumetric efficiency. 2

Rotary compressors, Classification, Centrifugal compressor, Axial compressors, Surging and stalling, Roots blower, Vaned compressor. 2

BOOKS:

1. Fundamentals of Internal Combustion Engine by Gill, Smith, Ziurs, Oxford & IBH Publishing CO
2. IC Engines, by Rogowsky, International Book Co.
3. A Course in International Combustion Engines, by Mathur & Sharma, Dhanpat Rai & Sons.
4. I.C Engine Analysis & Practice by E.F Obert.
5. I.C Engine, by Ganeshan, Tata Mc Graw Hill Publishers.
6. I.C Engine, by R. Yadav, Central Publishing House, Allahabad
7. Reciprocating and Rotary Compressors, by Chlumsky, SNTI Publications, Czechoslovakia
8. Turbines, Compressors and Fans, by S.M. Yahya, Tata Mc Graw Hill Pub.

EME-551 : MACHINE DESIGN-I Lab

L T P
0 0 2

Note: Eight experiments out of the following are to be performed. Students are advised to use design data book for the design. Drawing shall be made wherever necessary on small drawing sheets

1. Design & drawing of Cotter joint.
2. Design & drawing of Knuckle joint
3. Design of machine components subjected to combined steady and variable loads
4. Design of eccentrically loaded riveted joint
5. Design of boiler riveted joint
6. Design of shaft for combined constant twisting and bending loads
7. Design of shaft subjected to fluctuating loads
8. Design and drawing of flanged type rigid coupling
9. Design and drawing of flexible coupling
10. Design and drawing of helical spring
11. Design and drawing of screw jack

EAU 551 THEORY OF MACHINES LAB**L T P
0 0 2**

List of Experiments

1. To study various types of Kinematic Links, pairs, chains and Mechanisms.
2. To study inversions of 4 Bar mechanisms. Single and double slider crank mechanisms.
3. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism.
4. Create various types of linkages mechanism in CAD and simulate for motion outputs and study the relevant effects.
5. To generate spur gear involute tooth profile using simulated gear shaping process.
6. To study various types of gear - Helical, cross helical worm, bevel gear.
7. To study various types of gear trains -simple, compound, reverted, epicyclic and differential.
8. Determine the moment of inertia of connecting rod by compound pendulum method and tri-filer suspension pendulum.
9. To perform the experiment for static balancing on static balancing machine.
10. To perform the experiment for dynamic balancing on dynamic balancing machine.
11. To study the effect of unbalance of rotating mass on hard bearing balancing machine.
12. To study gyroscopic effects through models.
13. To determine gyroscopic couple on Motorized Gyroscope.

Note:

1. At least ten experiments are to be performed in the semester.
2. At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

EME-553 : MANUFACTURING SCIENCE -II – LAB**L T P
0 0 3**

Say, min 8 experiments out of the following

(or such experiment along-with study of the machines/processes)

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
2. Bolt (thread) making on Lathe machine
3. Tool grinding (to provide tool angles) on tool-grinder machine.
4. Gear cutting on Milling machine.
5. Machining a block on shaper machine.
6. Finishing of a surface on surface-grinding machine.
7. Drilling holes on drilling machine and study of twist-drill.
8. Study of different types of tools and its angles & materials.
9. Experiment on tool wear and tool life.
10. Experiment on jigs/Fixtures and its uses
11. Gas welding experiment
12. Arc welding experiment
13. Resistance welding experiment.
14. Soldering & Brazing experiment
15. Experiment on unconventional machining.
16. Experiment on unconventional welding.
17. Experiment on TIG/MIG Welding.
18. Macro and Microstructure of welding joints, HAZ.

EME-554 : HEAT & MASS TRANSFER – LAB**L T P
0 1 2**

Minimum 10 experiment of the following

1. Conduction - Composite wall experiment
2. Conduction - Composite cylinder experiment
3. Convection - Pool Boiling experiment
4. Convection - Experiment on heat transfer from tube-natural convection.
5. Convection - Heat Pipe experiment.
6. Convection - Heat transfer through fin-natural convection .
7. Convection - Heat transfer through tube/fin-forced convection.
8. Any experiment on Stefan's Law, on radiation determination of emissivity, etc.
9. Any experiment on solar collector, etc.
10. Heat exchanger - Parallel flow experiment
11. Heat exchanger - Counter flow experiment
12. Any other suitable experiment on critical insulation thickness.
13. Conduction - Determination of thermal conductivity of fluids.
14. Conduction - Thermal Contact Resistance Effect.

EAU 602 AUTO FUELS AND LUBRICANTS**L T P
3 1 0****OBJECTIVE:**

At the end of the course, the students are expected to acquire knowledge about the properties of fuels and lubricants for the design and operation of the I.C. engines.

UNIT I**MANUFACTURE OF FUELS AND LUBRICANTS**

Structure of petroleum refining process, classification of petroleum fuels, thermal cracking, catalytic cracking, polymerization, alkylation isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT II**PROPERTIES & TESTING OF FUELS**

Thermo-chemistry of fuels, properties and testing of fuels & Lubricants, relative density, calorific value, fire point, distillation, vapor pressure, flash point, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index. API gravity, aniline point Viscosity index etc.

UNIT III**Fuel rating & additives**

Cetane rating, fuel requirements. Additive - mechanism, requirements of an additive, petrol fuel additives and diesel fuel additives - specifications of fuels.

UNIT IV**COMBUSTION**

SI Engine - name propagation and mechanism of combustion, normal combustion, knocking, octane, rating. fuel requirements. CI engine, mechanism of combustion, diesel knock.

UNIT V**ALTERNATE FUELS**

Use of alternate fuel in engines- LPG. CNG need for alternate fuels, availability & their properties, general use of alcohols. LPG. CNG. LNG, hydrogen, ammonia, vegetable oils, bio-diesel & biogas. merits &

demerits of alternate fuels. Introduction to alternate energy sources like, electric vehicle, hybrid, fuel cell & solar cars.

UNIT IV

LUBRICANTS

Classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease- classification, properties, test. Specific requirements for automotive lubricants, oxidation, deterioration and degradation of lubricants, additives, synthetic lubricants.

UNIT VII

THEORY OF LUBRICANTS

Engine friction - introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.

TEXTBOOKS

1. Internal Combustion Engineering by Ganesan V. TaU McGraw -Hill Publishing Co .. Nev, Delhi.
2. Lubrication. Raymond G. Gunther, Chipton Book Co., 1971.

REFERENCEBOOKS

1. Fuels - Solids. Liquids. Gaseous by Brame. J.S.S. and King. I .G.
2. Fuels and Fuel Technology by Francis, W, Vol. I & II
3. Modern Petroleum Technology by Hobson, G.D. & Pohl. W
4. Lubrication-A practical guide to lubricant selection by A.R. Lansdown. Pergamon press, 1982.
5. Energy today & tomorrow by Maheswar Dayal, I & B Horishr India.
6. Internal Combustion Engineering and Air Pollution by Oibert. E.F.: International Book Co 1988.

EAU603 DESIGN OF AUTOMOTIVE COMPONENTS

L T P
3 1 0

UNIT-1

CLUTCH DESIGN CALCULATION

Design of single plate clutch, multi plate clutch, design of centrifugal clutch, cone clutch, energy dissipated, torque capacity of clutch, design of clutch components, design details of roller and sprag type of clutches.

UNIT-II

GEAR BOX

Performance of vehicle, total resistance to motion, traction and tractive effort, acceleration, calculation of gear ratio, design of three speed gear box, design of four speed gear boxes.

UNIT – III

VEHICLE FRAME AND SUSPENSION

Study of loads, moments and stresses on frame members, computer aided design of frame for passenger and commercial vehicles, computer aided design of leaf springs, coil springs and torsion bar springs.

UNIT – IV

FRONT AXLE AND STEERING SYSTEMS

Analysis of loads, moments and stresses at different sections of front axle, determination of loads at kingpin bearings, wheel spindle bearings, choice of bearings, determination of optimum dimensions and proportions for steering linkages ensuring minimum error in steering.

UNIT - V FINAL DRIVE AND REAR AXLE

Design of propeller shaft, design details of final drive gearing, design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings.

TEXT BOOKS

1. Giri.N.K- "Automobile Mechanics"- Khanna Publisher, New Delhi- 2002

REFERENCES

1. Heldt.P.M - "Automotive Chassis"- Chilton Co., New York- 1992
2. Steeds. W -"Mechanics of Road Vehicles"- Illiffe Books Ltd., London- 1990
3. Giles.K.G - Steering, Suspension and tyres"- Illiffe Books Ltd., London – 1988
4. Newton Steeds & Garret- "Motor Vehicle"- Illiffe Books Ltd., London – 2000
5. HeldtF.M- "Torque converter" - Chilton Book Co., New York – 1982
6. Dean Averns - "Automobile Chassis Design"- Illiffe Books Ltd - 1992

EAU-653 : MACHINE DESIGN-II Lab

L T P
0 1 2

A. Computer and Language : students are required to learn the basics of computer language such as C and C++ so that they should be able to write the computer programme (*3practical turns*)

B. Writing Computer programme for conventional design: Students are required to write computer program and validate it for the design of machine components done in theory subject (*5practical turns*)

C. Mini Project: Each student will be given a real life problem for the complete design of a subsystem/system using either manual calculation with the help of design handbook or through computer programme, if needed. This will be done as home assignment to be submitted at the end of the semester.

EAU 652 FUELS AND LUBRICATION LAB

L T P
0 0 2

EXPERIMENTS

1. Temperature dependence of viscosity of lubrication oil by Redwood Viscometer.
2. Viscosity Index of lubricating oil by Saybott Viscometer.
3. Flash and Fire points of Diesel, K-Oil, Bio Diesel.
4. Flash and Fire points of lubricants.
5. Drop point of grease and mechanical penetration in grease.
6. Calorific value of liquid fuel.
7. Calorific value of gaseous fuel
8. Study of semi solid lubrication in various Automobile Unit & Joints
9. Study of lubrication in transmission, final drive, steering gearbox.
10. Study of analytical equipment for oil analysis.
11. To find out volatility characteristic of different fuels by ASTM distillation methods (diesel, gasoline-lubricants).

Note: At least ten experiments are to be performed during the semester.

EAU 651 1C ENGINE AND AUTOMOBILE LAB

L T P
0 0 3

EXPERIMENTS

1. To study constructional details and prepare layouts of front engine/rear engine drive lines.
2. Performance of CI and SI engine
3. Impact of Variable compression ratio on Performance
4. To study constructional details and prepare layout of four wheel drive line
5. To study construction of single plate and multi plate clutches and draw sketches.
6. To study construction of diaphragm type clutch and draw sketches.
7. To study and prepare layouts of sliding mesh and constant mesh gear boxes.
8. To study construction of front & rear suspension systems and draw sketches.
9. To study construction of steering system for manual/power arrangement and draw sketches.
10. To study construction of hydraulic braking (disc/drum) systems and functioning of master & wheel cylinders and draw sketches.
11. To study construction of different types of Automobile Wheels and Tyres & draw sketches.
12. To study constructional details and prepare layout of different types of Cooling systems.
13. To study construction of power assisted braking systems and draw sketches.
14. To study & prepare layout of Lubrication System in Automobiles.

Note: At least ten experiments are to be performed in the semester.

UNIT-1

Computers in industrial Manufacturing: Product cycle, CAD / CAM Hardware, Basic structure, CPU, Memory types, input devices, display devices, hard copy devices, storage devices.

UNIT-II

Computer Graphics: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections, clipping, hidden surface removal.

UNIT-III

Geometric modeling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.

UNIT -IV

Drafting and Modeling systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling.

UNIT-V

Numerical control: NC, NC modes, NC elements, NC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming.

UNIT-VI

Group Tech: Part family, coding and classification, production now analysis, advantages and limitations, Computer Aided Processes Planning, Retrieval type and Generative type.

UNIT - VII

Computer aided Quality Control: Terminology in quality control, the computer in ac, contact inspection methods, noncontact inspection methods-optical, noncontact inspection methods-nonoptical, computer aided testing, integration of CAQC with CAD/CAM.

UNIT-VIII

Computer integrated manufacturing systems: Types of Manufacturing systems, Machine tools and related equipment, material handling systems, computer control systems, human labor in the manufacturing systems, CIMS benefits.

TEXT BOOKS:

1. CAD / CAM A Zimmers & P.Groover/PEIPHI
2. CAD/CAM Theory and Practice /Ibrahim Zeid/TMH

REFERENCES:

1. Automation, Production systems & Computer integrated Manufacturing! Groover/P.E
2. CAD/CAM/CIM/Radhakrishnan and Subramanian /New Age
3. Principles of Computer Aided Design and Manufacturing /Farid Amirouche / Pearson
4. CAD/CAM: Concepts and Applications/Alavalal PHI
5. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson

EAU-702 AUTOMOTIVE POLLUTION AND CONTROL**UNIT- 1**

Introduction: Pollutants-sources-formation-effects-transient operational effects on pollution.

UNIT- II

SI engine Combustion and Pollutant Formation: Chemistry of SI engine Combustion, HC and CO formation in 4 stroke and 2 stroke SI engines, NO formation in SI Engines, Effect of operating variables on emission formation.

UNIT- III

CI engine Combustion and Emissions: Basic of diesel combustion-Smoke emission in diesel engines- Particulate emission in diesel engines. Color and aldehyde emissions from diesel engines, Effect of operating variables on emission formation.

UNIT –IV

Control Techniques for SI and CI: Design changes, optimization of operating factors, exhaust gas re-circulation, fumigation, air injector PCV system-Exhaust treatment in SI engines-Thermal reactors-Catalytic converters, Catalysts, Use of unleaded petrol.

UNIT –V

Test Procedure & Instrumentation for Emission Measurement and Emission Standards: Test procedures-NDIR analyzer, Flame ionization detectors, Chemiluminescent analyzer, Gas chromatograph, Smoke meters, Emission standards.

Reference:

1. Mathur M. L., Internal Combustion Engines
2. Ganesan. V., Internal Combustion Engines, Tata McGraw Hill Co.
3. Obert. E.F., Internal Combustion Engines.
4. Taylor. C.F., Internal Combustion Engines, MIT Press.
5. Heywood. J.B., Internal Combustion Engine Fundamentals, McGraw Hill Book Co.

EAU 751 CAD/CAM Lab

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0 0 3

1. Drafting : Development of part drawings for various components in the form of orthographic and isometric. Representation of Dimensioning and tolerances scanning and plotting. Study of script, DXE AND IGES FILES.
2. Part Modeling: Generation of various 3D Models through Protrusion, revolve, shell sweep. Creation of various features. Study of parent child relation. Feature based and Boolean based modeling surface and Assembly Modeling Study of various standard Translators. Design simple components.
3.
 - a. Determination of deflection and stresses in 2D and 3D trusses and beams.
 - b. Determination deflections component and principal and Von-mises stresses in plane stresses in plane stress, plane strain and Axisymmetric components.
 - c. Determination of stresses in 3D and shell structures (at least one example in each case) d. Estimation of natural frequencies and mode shapes. Harmonic response of 20 beam. e. Study state heat transfer Analysis of plane and Axisymmetric components.
4.
 - a) Development of process sheets for various components based on tooling Machines.
 - b) Development of manufacturing detects and tool management systems.
 - c) Study of various post processors used in NC Machines.
 - d) Development of NC code for free from and sculptured surfaces using CAM packages.
 - e) Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM package. Through RS 232.
 - f) Quality Control and inspection.

Packages: Use of Auto CAD, Micro Station, CATIA, Pro-E, 1-DEAS, ANSYS. NISA, CAEFEM, ibbs CAM, Master CAM etc,

1. Study of Pressure pickups, charge amplifier, storage oscilloscope and signal analysers used for IC engine testing.
2. Performance study of petrol and diesel engines both at full load and part load conditions.
3. Morse test on petrol and diesel engines.
4. Determination of compression ratio, volumetric efficiency and optimum cooling water flow rate in engines.
5. Heat balance test on an automotive engine.
6. Testing of 2 and 4 wheelers using chassis dynamometers.
7. Study of NDIR Gas Analyser and FID
8. Study of Chemiluminescent NOx analyzer
9. Measurement of HC, CO, CO₂, O₂ using exhaust gas **analyzer**
10. Diesel smoke measurement

References:

1. Giles. J.G., Vehicle Operation and performance, Hliffe Books Ltd., London, 1989.
2. Grouse. W.H. and Anglin. D.L., Motor Vehicle Inspection, McGraw Hill Book Co., 1978.
3. Ganesan. V., Internal Combustion engines, Tata McGraw Hill Co., 1994. 4JBIS code Books, IS-10000 series, 1988.

EAU 801 : Trouble shooting, Servicing & Maintenance of Automobile

UNIT I

Automobile maintenance : Importance of maintenance, scheduled and unscheduled maintenance. preparation of check lists, analysis of breakdown, preventive measures, unit replacement system, maintenance schedule, chassis lubrication schedule, component retrieval, estimating repair cost, maintenance record, warranty period, servicing. Inspection forms. Log books. Trip sheets. Other maintenance record forms. Garage practice : Types of service station/garage, layout of garage. Factors affecting layout, tools & equipments, transport service undertakings, design a layout for different garage. 8

UNIT II

Engine Maintenance : Dismantling of engine components, cleaning methods, visual inspection and dimensional check of various engine components, minor and major tune up, reconditioning and repairing methods of engine components. Assembly procedure, special tools used for maintenance, repair and overhauling. 5
Cooling Systems-Anti corrosion and antifreeze solutions, radiator, and thermostat. Lubrication oil topping up, oil change, oil relief valve; fuel feed systems, FIP adjustment and testing, injector testing. 5

UNIT III

Chassis and drive line maintenance: Mechanical automotive type gear box- mechanical automatic types. Final reduction, propeller shaft, front and rear suspension systems, brake systems-hydraulic, servo, air. Air bleeding, steering system, axles, wheel alignment-tires. 7

UNIT IV

Electric system maintenance : Battery testing method, starter motor, charging system - a DC generator, AC alternator, regulator, ignition system- coil ignition, transistor assisted ignition, capacitor discharge ignition. Electric horn, wiper motor, flasher, electric fuel pump, gauges. Lighting system- head lights focusing. Wiring harness testing. 7

UNIT V

Body repair : Minor body panel beating, tinkering, shouldering. Painting : Introduction of automotive paints, types of paints, corrosion and anticorrosion method, rubbing polishing, working of paint booth, door lock mechanism, window glass actuation mechanism. 8

TEXTBOOK:

1. John Doke "Fleet Management", McGraw-Hill Co. 1984.

2. Maleev. V.L., "Diesel Engine operation and Maintenance", Maintenance, McGraw Hill book Co., New York, 1954.

REFERENCES:

1. Judge. A.N., "Motor vehicle engine servicing, 3rd, Edition", Pitman Paperpack, London, 69.
2. Judge. A.W., "Maintenance of High speed diesel engines", Chapman Hall Ltd., London, 56.
3. John. W.Vale.J.R., "Modern Aut Body and Finder repair".
4. Venk. Spicer. "Automotive Maintenance and Trouble shooting".
5. "Vehicle Service Manuals of reputed manufactures. "

DETAILS OF DEPARTMENTAL ELECTIVES

ELECTIVE-1

EAU -011 : AUTOMOTIVE CHASSIS AND SUSPENSION

L T P
3 1 0

Unit-1

Introduction : Types of chassis, chassis layout, vehicle body, chassis lubrication, four wheel drive, transfer box rear engine vehicles. Materials of chassis and body. Vibration dampers. 2

Propeller shaft & universal joints : torque tube & Hotchkiss drive, hook's types universal joint, shaft whirling, C.V. joint, divided propeller shaft, rubber universal coupling, slip joint. 2

Final drive & rear Axle : purpose of differential, construction and working, non slip differential, chain sprocket final drive, cone pulleys. Live & dead axles. Fully floating, semi floating & three quarter floating axles, uses. 3

Unit-2

Steering System : types of steering system, Ackermann principle, davis steering gears, system components, steering gear boxes. Rack and pinion steering gear, types of steering linkages, power steering wheel geometry, caster, camber, toe-in, toe-out, wheel alignment, balancing 4

Brakes : types of brake, mechanical, hydraulic, pneumatic brakes, disc and drum brakes, self energizing brakes, engine brakes, brake system components, valves, caliper, and brake shoes. 3

Unit-3

Suspension : purpose, front and rear suspension, two & 4 wheel independent suspension. Suspension system components, leaf springs, coil springs, dampers, torsion bars. MacPherson strut, stabilizer bars, arms etc. air suspension system. Types of front and rear suspension system. 6

Wheel & tyres. : Types of wheels, construction, wired wheels, tyres, construction, types, radial, bias & belted bias, comparison, slip angle, under and over steering, tread patterns, tyre re-treading cold and hot, tyre specification tubeless tyre. 2

Unit-4

Transmission requirements : Requirements of transmission system, general arrangements for power transmission for front engine, rear engine vehicle, four wheel drive vehicle, dead axle and axle less transmission. 3

Clutch : Single plate, multi plate clutch, centrifugal clutch, electromagnetic clutch, constructional details, torque capacity and clutch friction materials. 3

Gear Box : Requirements of gear box, sliding mesh gear box, constant mesh gear box synchromesh gear box, epicyclic gear box, velocity ratio and gear ratio for vehicle, performance characteristics in different speed, overdrive 3

Unit-5

Fluid Coupling: principle of operation, constructional details, torque capacity and performance curve. 2

Torque converter : principle of operation, constructional details, torque capacity and performance curve. Multistage torque converter, converter fluid. 1

Hydrostatic drive : Various types of hydrostatic system, working principle of hydrostatic system, advantage and limitations, Jenny hydrostatic drive, comparison of hydrostatic and hydrodynamic drive. **2**

Electric drive : Principle of electric drive, Early ward leonard control system, Modify Leonard control system, advantage of electric drive, limitation of electric drive. **2**

Automatic Transmission : Need for automatic Transmission, Chevrolet turbo glide transmission system, torque Flite, Automatic transmission fluid, effect of automatic transmission on vehicle performance and fuel economy. **2**

Text Book

1. "Automobile engineering", Dr. Kripal Singh.
2. Automobile engineering" K.M. Gupta.
3. Heldt P.M., "Automotive chassis", Chilton Co., New York.
4. Giles J.G., "Steering, Suspension and tyres", Iliffe Book Co., London.

EAU 012 TRIBOLOGY

L T P
3 1 0

UNIT-I

Study of various parameters: Viscosity, flow of fluids, viscosity and its variation-absolute and kinematic viscosity, temperature variation, viscosity Index determination of viscosity, different viscometers used. Hydrostatic lubrication: Hydrostatic step bearings, applications to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearings.

UNIT II

Hydrodynamic theory of lubrication: Various theories of lubrication, petroffs equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl anti –friction bearing.

UNIT-III

Friction and power losses in journal bearings: Calibration of friction loss friction in concentric bearings, bearing modulus, Somraerfield number, heat balance, practical consideration of journal bearing design considerations.

UNIT-IV

Air lubricated bearing: Advantages and disadvantages application to Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect. Study of current concepts of boundary friction and dry friction.

UNIT-V

Types of bearing oil pads: Hydrostatic bearing wick oiled bearings, oil rings, pressure feed bearing, partial bearings -externally pressurized bearings.

Bearing materials: General requirements of bearing materials, types of bearing materials.

TEXT BOOKS:

1. Fundamentals of Tribotogy, Basu, SenGupta and Ahuja, PHI
2. Tribotogy in Industry: Sushil Kumar Srivatsava, S. Chand &Co.

REFERENCE:

1. Tribology - B.C. Majumdar

EAU 013 ROBOTICS AND AUTOMATION

L T P
3 1 0

UNIT - I: BASIC CONCEPTS

Automation and Robotics - An over view of Robotics - present and future applications - classification by • coordinate system and control system, Dynamic stabilization of Robotics.

UNIT - II: POWER SOURCES AND SENSORS

Hydraulic, Pneumatic and electric drivers - Determination HP of motor and gearing ratio, variable speed arrangements, Path Determination - Machinery Vision - Ranging - Laser - Acoustic, Magnetic Fiber Optic and Tactile Sensor

UNIT - III: MANIPULATORS, ACTUATORS AND GRIPPERS

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators. Pneumatic, Hydraulic Actuators, Stepper Motor Control Circuits, End Effector, Various types of Grippers, Design consideration.

UNIT - IV: KINEMATICS

Differential transformation and manipulators, Jacobians - problems. Dynamics: Lagrange - Euler and Newton -Euler formations - Problems.

Forward and Inverse Kinematic Problems, Solutions of Inverse Kinematic problems, Multiple Solution, Jacobian Work Envelop - Hill Climbing Techniques.

UNIT-V: PATH PLANNING

Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion - straight line motion - Robot programming, languages and software packages.

CASE STUDY

Multiple Robots - Machine Interface - Robots in Manufacturing and Non-Manufacturing applications - Robot Cell Design Selection of a Robot

TEXTBOOKS:

1. Industrial Robotics / Groover M P / Pearson Edu.
2. Robotics / Fu K S / McGraw Hill.

REFERENCES:

1. Robotics, CSP Rao and V.V. Reddy, Pearson Publications (In press)
2. Robotics and Control / Mittal R K & Nagrath IJ / TMH.
3. An Introduction to Robot Technology, / P. Coiffet and M. Chaironze / Kogam Page Ltd. 1983 London.
4. Robotic Engineering / Richard D. Klafter, Prentice Hall

5. Robot Analysis and Intelligence / Asada and Slow time / Wiley Inter-Science
6. Introduction to Robotics / John J Craig / Pearson Edu.

Department Elective-II

EAU 021 VEHICLE TRANSPORT MANAGEMENT

L T P
3 1 0

UNIT-I

Historical Back ground: Introduction, the growth of a network, trams, trolley buses, private car's subsidies
The Infrastructure: Road- Approach Road. Highways National, State, District, traffic condition, relief of congestion, pedestrians, zebra lines, margins, shopping centres. Bus-stops, shelters. Bus stations. Garages layout of premises, equipment, use of machinery, conveyance of staff, facilities for passengers. Maintenance -preventive, breakdown, overhauling -major, minor.

UNIT -II

Organisation and Management: Forms of ownership, principle of transport, management -internal organisation, centralised condition, decentralised condition (Engineering, traffic and administration), staff administration: industrial relation, administration, recruitment and training, welfare, health and safety.
Public relations divisions: Dissemination of information, maintaining goodwill- handling complaints, traffic advisory, committees- local contractors co-operation with the press news and articles- facilities for visitors- forms of publicity importance of quality -inter departmental liaison advertisements, signs, notice and directions general appearance of premises, specialized publicity.

UNIT-III

Prevention of accidents: Emphasis of safe driving-annual awards bonus encouragement vehicle design platform, layout, location of steps, scheduled route hazards records elimination of accident prone devices.
Route planning: Source of traffic, town planning, turning points, stopping places, shelters survey of route preliminary schedule test runs elimination of hazards factors affecting. Frequency direction of traffic flow estimated traffic possibility single verses double deck.

UNIT-IV

Timing, bus working and schedules: Time table layout uses of flat graph method of presentation preparation of vehicle and crew schedule preparation of the duty roster, co-operation with employers use of the vehicle running numbering determination of vehicle efficiency, checking efficiency of crew, duty arrangements. Fare collections systems: Principles of collection the way bill, bell punch system reduced ticket stocks willk brew system T.I.M and straight M/C/S. The verometer lenson parason coach tickets exchanges, box system personal and common stock flat fare platform control.

UNIT-V

The fare structure: Basis of fares historical background effects of competition and control calculating average zone system straight and tapered scale elastic and inelastic demand coordination of fares concessions fares changes for workman. Anomalies double booking inter availability through booking and summation private hire charges. Operating cost and types of vehicles: Classification costs, average speed running costs

supplementary costs depreciation obsolescence, life of vehicles sinking fund factor affecting post per vehicles mile incidence of wages and overheads 100 seats miles basis, average seating capacity vehicles size and spread overs, types of vehicle economic considerations authorization of trolley, bus services, statutory procedure taxes and hire cars.

TEXTBOOKS:

1. Bus operation -L.d kitchen, iliffe & sons
2. Bus & coach operation -Rex w. fautks. butterworth version of 1987

EAU022 AUTOMOTIVE ELECTRICAL AND AUTORONICS

L T P
3 1 0

UNIT-I:

Storage Battery: Principles of lead acid cells and their characteristics, construction and working of lead acid battery. types of batteries, testing of batteries, effect of temperature on capacity and voltage, battery capacity, voltage, efficiency, charging of batteries, sulphation and desulphation, maintenance and servicing. Fault diagnosis. New developments in electrical storage.

UNIT-II:

Ignition System: Conventional ignition system and study of its components. Types of ignition systems, spark advance and retarding mechanisms. Types of spark plugs, ignition timing, maintenance, servicing and fault diagnosis. Electronic ignition systems, programmed ignition, distributorless ignition,

a) **Starter motor:** Construction and working of series and shunt automotive starter motor, types of device arrangement, solenoid switches, starter motor troubles and repairs.

b) **Electronic controls of carburetion,** component of fuel injection systems, multipoint injection. Bosch Lvariation electronic control diesel fuel injection.

UNIT-III:

Charging system: Principle of generation of direct current. Principle, construction and working of alternator generating systems. Maintenance, servicing and trouble shooting. Bosch com- pact alternator. Wiring for auto

electrical Systems: Earth return and insulated return systems, six volt and twelve volt systems, fusing of circuits, low and high voltage automotive cables, wiring diagram for typical automotive wiring systems, maintenance and servicing.

Unit-IV:

Dash board units and electrical accessories: Principle of automobile illumination, head lamp construction and wiring, horn, wind screen wiper signalling devices, fog lamps, auxiliary lighting, temperature gauge, oil pressure gauge, fuel gauge, speedometer, odometer.

Unit-V

Number system codes and data representation: Binary numbers, number base conversion, decimal, octal and hexadecimal numbers, BCD codes, memory representation of positive and negative integers, conversion real numbers, floating point notations and representations of floating point numbers, binary arithmetics, addition and subtraction of binary numbers, ones and two's complement method. Logic gates, arithmetic circuits and introduction to microprocessors: Study of basic and universal logic gates, study of X-OR and X-NOR gates, flip flop, S-R, S-J flip flop and counters and shift registers, half adders and subtracters.

TEXTBOOKS:

1. Automotive Electrical auxiliary systems -By N R. Khatawale Digital

REFERENCES:

1. Automotive Electrical systems -By Young and Griffith, Butterworth
2. Basic automotive electrical systems -By C.P. Nakra, Dhanpat Rai.
3. Automotive mechanics -By William H. Grouse, TMH 5. Modern Electrical Equipments -By A. W. Judge,
4. Automotive Electrical Equipment -By P.I. Kohli, TMH

EAU 023 PRODUCT DESIGN AND ASSEMBLY AUTOMATION

L T P
3 1 0

UNIT-I

AUTOMATIC FEEDING AND ORIENTING DEVICES: Vibrator feeders: Mechanics of vibratory conveying. estimating the mean conveying velocity, load sensitivity, solutions to load sensitivity, spiral elevators, balanced feeders. Orientation of typical oriental system, effect of active orienting devices on feed rate, analysis of orienting systems, performance of an orienting device, natural resting aspects, of parts for automatic handing, analysts of a typical orienting system, out-of-bowl tooling. Mechanical feeders. Reciprocating -tube hopper feeder; magazines: :

UNIT-II

Assembly Automation: Development of the assembly process, choice of assembly method, automation advantages, social effects of automation.

automatic assembly transfer systems: Continuous transfer. Intermittent transfer, indexing mechanisms, and operator - paced free - transfer machine.

UNIT-III

product design for high speed automatic assembly and robot assembly: Introduction, design of parts for: high speed, feeding and orienting, example, additional feeding difficulties, high speed automatic insertion, example, aifalysis of an assembly, general rules for product design for automation, design of parts for feeding and orienting, summary of design rules for high speed automatic assembly, product for robot assembly.

UNIT-IV

design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling lime, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of Insertion time.

UNIT-V

Avoiding jams during assembly, reducing risk assembly problems, effects of holding down, manual assembly data base and design data sheets, application of the DFA methodology and general design guidelines.

performance and economics of assembly systems: indexing machines, free transfer machines, basis for economic comparisons of automation equipment, comparison of indexing and free transfer machines' economics of robot assembly.

feasibility study for assembly automation: machine design factors to reduce machine downtime due to defective parts, feasibility study.

TEXTBOOK:

1. Geoffrey Boothroyd. "Assembly Automation and Product Design", Marcel Dekker Inc.. NY 1992

REFERENCES:

1. Geoffrey Boothroyd, "Hand Book of Product Design¹ Marcel and Dekken, N.Y. 1990
2. A Delbainbre "Computer Aided Assembly London. 1992.

Department Elective-III**EAU 031 VEHICLE BODY ENGINEERING AND SAFETY****L T P
3 1 0****UNIT-I: MATERIALS**

Structural materials: Aluminum alloy sheet, extrusion and casting, Austenitic and Ferritic stainless steels, alloy steels. Different types of composites, FRP & metal Matrix Composites. Structural timbers properties designing in GRP and high strength composites different manufacturing techniques of composites.

Thermo plastics, ABS and styrenes. Load bearing plastics, semi rigid PUR foams and sandwich panel construction

UNIT-II: ERGONOMICS AND CONTROLS

Shaping and packaging: Product design and concepts, Aesthetics and industrial design, formal aesthetics and shape, computer aided drafting, surface development, interior ergonomics, ergonomics system design, dashboard instruments, advances in electronic display, CV legal dimension. CV-cab ergonomics, mechanical package layout. Body Fitting and I Controls: Driver's seat, window winding mechanism, Door lock mechanism, other interior mechanisms, driver's visibility' and tests for, visibility, minimum space, requirements and methods or improving space in cars, electric wiring and electronic control systems, advanced body electronics, networking or body systems controls.

UNIT-III: AERODYNAMICS AND FORCE ANALYSIS

Aerodynamics: Basics, aerofoils, aerodynamics drag lift, pitching, yawing and rolling moments, determination of aerodynamic coefficients (wind tunnel testing), racing car aerodynamics, bluff body aerodynamics, local air flows. Load Distribution: Types of load carrying structures -closed, integral, open, flat types. Calculation of loading cases-static, asymmetric, vertical loads. Load distribution, stress analysis of structure, body shell analysis.

UNIT-IV: STRUCTURAL DYNAMICS

Noise, Vibration, Harshness: Noise and vibration basics, body structural vibrations, chassis bearing vibration, designing against fatigue, rubber as an isolator. CV body mountings, automatic enclosures, sandwich panels, structure dynamics applied, surety under impact: Impact protection basics, design for crash worthiness, occupant and cargo restraints. Passive restraint systems, slide impact analysis, bumper system, energy absorbant foams, laws of mechanisms applied 10 safety. Vehicle stability: Steering geometry vehicle and a curvilinear path, and lateral stability, effects of tyre factors, mass distribution and engine location on stability.

UNIT-V: TYPES OF VEHICLES

Vans, trucks and buses: Types of mini coach with trailers, single and double deckers, design criteria based on passenger capacity, goods to be transported and distance to be Covered, constructional details: weights and dimensions, conventional and integral type.

TEXTBOOKS:

1. Body Engineering -Sydney F Page
2. Vehicle body engineering -Giles J Pawlowski,

REFERENCES:

1. Automotive chassis -P.M. Heldt. chilton & Co
2. Handbook on vehicle body design -SAE Publications.

EAU 032 AUTOMOTIVE AERODYNAMICS**L T P
3 1 0****UNIT_I****INTRODUCTION**

Scope - historical development trends - Fundamental of fluid mechanics - Flow phenomenon related to vehicles
External & Internal flow problem - Resistance to vehicle motion - Performance - Fuel consumption and performance - Potential of vehicle aerodynamics.

UNIT-II**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.

UNIT-III**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.

UNIT-IV**VEHICLE HANDLING**

The origin of forces and moments on a vehicle - side wind 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.

UNIT-V**WIND TUNNELS FOR AUTOMOTIVE AERODYNAMIC**

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.

TEXTBOOKS:

1. Hucho.W.H., "Aerodynamic of Road vehicles ", Butterworths Co. Ltd., 1997.

References:

1. Pope. A., " Wind Tunnel Testing ", John Wiley & Sons, 2ndEdn, New York, 1974.
2. Automotive Aerodynamic: Update SP-706, SAE,

EAU 033 OPTIMIZATION FOR ENGINEERING DESIGN

L T P
3 1 0

UNIT-I

Single Variable Optimization for engineering design: Introduction-Engineering optimization problems-Optimality criteria-Bracketing

UNIT-II

methods-Region elimination methods-Point estimation methods-Gradient based methods-Root finding using optimization techniques-Computer programmes.

UNIT-III

Multi Variable Optimization Algorithm: Optimality criteria-Unidirectional search-Direct search methods-gradient based methods-Computer programmes.

UNIT-IV:

Constrained Optimization Algorithms: Kuhn - Tucker conditions -Transformation methods - sensitivity analysis Direct search for constrained minimization-Linearized search techniques - feasible direct method-generalized reduction gradient method-Gradient projection method- Computer programmes.

UNIT-V:

Specialized Algorithms : Integer programming - Geometric programming.
Non-Traditional Optimization Algorithms: Genetic algorithms - Simulated annealing - Global optimization
Computer programmes.

REFERENCES:

1. Kalyanmay Deb, Optimization for Engineering Design, Prentice Hall of India, New Delhi.
2. Taha. M.A., Operations Research, Macmillan, New York, 1989
3. Rao.S.S., Optimisation Theory and Application, Wiley Eastern, New Delhi, 1990
4. Muirthy, Linear Programming, Wiley, New York, 1987.
5. Rekiatidis. G.V. Ravindran.A. And Regedell K.M., Engineering optimization methods and applications, Wiley, New York, 1986.
6. Conley. W., Computer Optimization Techniques, Prentice Hall Book, 1980.

Departmental Elective IV

EAU 041 ADVANCED AUTOMOBILE TECHNOLOGIES

L T P
2 1 0

UNIT I

The Future Of The Automotive Industry : Challenges and Concepts for the 21st century. Crucial issues facing the industry and approaches to meet these challenges. Fuel Cell Technology For Vehicles: What is fuel cell, Type of fuel cell, Advantages of fuel cell. Current state of the technology. Potential and challenges. Advantages and disadvantages of hydrogen fuel. Hybrid vehicles - Stratified charged / lean burn engines - Hydrogen engines - battery vehicles – Electric propulsion with cables - Magnetic track vehicles.

UNIT II

Latest Engine Technology Features: Advances in diesel engine technology. Direct fuel injection Gasoline engine. Diesel particulate emission control. Throttling by wire. Variable Valve Timing, Method used to effect variable Valve Timing. Electromagnetic Valves, Cam less engine actuation.

UNIT III

42 Volt System: Need, benefits, potentials and challenges. Technology Implications for the Automotive Industry. Technological evolution that will occur as a result of the adoption of 42 volt systems. Power system; power steering, power brakes, windows, Automated systems; computer controlled front collision prevention, navigation, GPS, engine check diagnosis system, wheel status air pressure, alignment, number of liters of diesel left, kilometers to be covered, mileage at each discrete interval. Preparation and maintenance of proper road network - National highway network with automated roads and vehicles - Satellite control of vehicle operation for safe and fast travel. Computer Control for pollution and noise control and for fuel economy - Transducers and actuators -Information technology for receiving proper information and operation of the vehicle like optimum speed and direction.

UNIT IV

Electrical And Hybrid Vehicles : Types of hybrid systems, Objective and Advantages of hybrid systems. Current status, Future developments and Prospects of Hybrid Vehicles Integrated Starter Alternator: Starts stop operation, Power Assist, Regenerative Braking. Advanced lead acid batteries, Alkaline batteries, Lithium batteries. Development of new energy storage systems. Deep discharge and rapid charging ultra capacitors.

UNIT-V

X-By Wire Technology: What is X-By Wire, Advantage over hydraulic systems. Use of Automotive micro controllers. Types of sensors. Use of actuators in an automobile environment. Vehicles Systems : Constantly Variable Transmission, Benefits, Brake by wire, Advantages over power Braking System. Electrical assist steering, Steering by wire, Advantages of Steering by wire. Semi-active and fully-active suspension system. Advantages of fully active suspension system.

TEXT & REFERENCE BOOKS:

1. Advanced Vehicle Technologies by Heinz Heisler- SAE International Publication.
2. Electric and Hybrid Electric vehicles by Ronald K. Jurgen.- SAE International Publication\
3. Electronic Braking, Traction and Stability control- SAE Hardbound papers.
4. Electronics steering and suspension systems- SAE Hardbound papers.
5. 42 Volt system by Daniel J. Holt- SAE International Publication
Diesel Particulate Emission by J.H. Johnson- SAE Hardbound papers. Fuel Cell Technologies for vehicles by Richard Stobart- SAE Hardbound papers.

EAU042 AUTOMOTIVE AIR-CONDITIONING

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3 1 0**

UNIT I: AIRCONDITIONING FUNDAMENTALS

Basic air conditioning system - Location of air conditioning components in a car - Schematic layout of a refrigeration system. Compressor components - Condenser and high pressure service ports. Thermostatic expansion valve - Expansion valve calibration - Controlling evaporator temperature - Evaporator pressure regulator - Evaporator temperature regulator.

UNIT II: AIR CONDITIONER - HEATING SYSTEM REFRIGERANT

Automotive heaters - Manually controlled air conditioner - Heater system - Ford automatically controlled air conditioner and heater systems - Automatic temperature control - Air conditioning protection - Engine protection.

UNIT III: AIR ROUTING & TEMPERATURE CONTROL

Containers - Handling refrigerants - Tapping into the refrigerant container - Refrigeration system diagnosis - Diagnostic procedure - Ambient conditions affecting system pressures. Evaporator care air flow through the Dash recirculating unit - Automatic temperature control - Duct system - Controlling flow - Vacuum reserve - Testing the air control and handling systems.

UNIT-IV: AIR CONDITIONING SERVICE

Air conditioner maintenance and service - Servicing heater system Removing and replacing components. Trouble shooting of air controlling system - Compressor service.

TEXT BOOK:

1. William H Grouse and Donald L Anglin, " Automotive Air conditioning ", McGraw-Hill Inc., 1990.

REFERENCES:

1. Mitchell information Services, Inc, " Mitchell Automatic Heating and Air Conditioning Systems ", Prentice Hall Ind., 1989.
- 2*Paul Weiser, " Automotive Air Conditioning ", Reston Publishing Co Inc., 1990.
3. MacDonald, K.L., " Automotive Air Conditioning ", Theodore Audel series, 1978.
4. Goings. L.F., Automotive Air Conditioning ", American Technical services, 1974.

EAU 043 INTERACTIVE COMPUTER GRAPHICS

L T P
3 1 0

UNIT-I

Introduction, Application area of Computer graphics, overview of graphic system, video-display devices, raster-scan systems, random scan systems, graphics monitors and work stations and input devices

UNIT-II

Output primitives: Points and lines, line drawing algorithms, mid-point circle algorithm. Filled area primitives: scan-line polygon fill algorithm, boundary-fill and flood-fill algorithm. 2-D geometrical transformations: Translation, scaling, rotation, reflection and shear transformation matrix representations and homogeneous coordinates, composite transformations, transformations between coordinates

UNIT-III

2-D viewing: The viewing pipe-line, viewing coordinate reference frame, window to view-port co-ordinate transformations, viewing function. Cohen-Sutherland and Cyrus-beck line clipping algorithms, Sutherland Hodgeman polygon clipping algorithm

UNIT-IV

3-D object representation: Polygon surfaces, quadric surfaces, spline representation, Hermite curve, Bezier curve and B-spline curve, Bezier and B-spline surfaces, Basic illumination models, shading algorithms
3-0 geometric transformations: Translation, rotation, scaling, reflection and shear transformation and composite transformations

UNIT-V

Visible surface detection methods: Classification, back-face detection, depth-buffer, scan-line, depth sorting
Computer animation: Design of animation sequence, general computer animation functions, raster animation, computer animation language, key frame system, motion specification

TEXT BOOKS:

1. Computer Graphics C version¹ Donald Hearn and M. Pauline Baker, Pearson/PHI
2. Computer Graphics Principles & practice", second edition in C, Foley, VanDarn, Feiner and Hughes, Pearson Education

REFERENCES:

1. Computer Graphics Second edition', Zhigand xiang, Roy Plastock. Schaum's outlines. Tata McGravv hill edition.
2. Procedural elements for Computer Graphics, David F Rogers, Tata Me Graw hili, 2nd edition.
3. Principles of Interactive Computer Graphics", Neuman and Sprout. TMH.
4. Principles of Computer Graphics. Shalini Govil, Pai, 2005, Springer.
5. Computer Graphics. Steven Harrington, TMH

Departmental Elective – V

EAU 051:COMPUTER AIDED VEHICLE DESIGN

**L T P
3 1 0**

Unit I:

VEHICLE FRAME AND SUSPENSION

Study of loads - moments and stresses on frame members. Computer aided design of frame for passenger and commercial vehicle - Computer aided design of leaf springs - Coil springs and torsion bar springs.

UNIT II:

FRONT AXLE AND STEERING SYSTEMS

Analysis of loads - moments and stresses at different sections of front axle. Determination of bearing loads at Kingpin bearings. Wheel spindle bearings. Choice of bearings. Determination of optimum dimensions and proportions for steering linkages ensuring minimum error in steering.

UNIT III:

CLUTCH

Torque capacity of clutch. Computer aided design of clutch components, Design details of roller and sprag type of clutches.

UNIT IV:

GEARBOX

Computer aided design of three speed and four speed gear boxes.

UNIT V: DRIVE LINE AND REAR AXLE

Computer aided design of propeller shaft. Design details of final drive gearing. Design details of full floating, semi-floating and three quarter floating rear shafts and rear axle housings¹.

TEXT BOOKS:

1. Dean Avern, " Automobile Chassis Design ", Illiffe Books Ltd, 1992.

References:

1. Heldt.P.M., " Automotive Chassis ", Chilton Co., New York, 1992.
2. Steeds. W., " Mechanics of Road vehicles ", Illiffe Books Ltd., London, 1990.
3. Giles.J.G., Steering, " Suspension and tyres ", Illiffe Books Ltd., London, 1988.
4. Newton, Steeds & Garret, " Motor vehicle ", Illiffe Books Ltd., London, 1982.
5. Heldt.P.M., " Torque converter ", Chilton Book Co., New York, 1982.
6. Giri.N.K. " Automobile Mechanics ", Khanna Publisher, New Delhi, 1996.

UNIT-I

Introduction: Need for non conventional energy sources. Energy alternative : solar, photo-voltaic, Hydrogen, Bio mass. Electrical - their merits and demerits.

UNIT-II

Solar photo-voltaic conversion, Collection and storage of solar energy, collection devices, flat plate collectors, concentrating *type* collectors, principles and working of photo-voltaic Conversion, Applications to automobiles.

UNIT-III

Energy from Bio mass: Photosynthesis, photosynthetic oxygen production, energy plantation. Bio gas production from organic waste, description of Bio gas plant, types of Bio gas plants, problems involved in production and transportation. Application of Bio gas in engines as a single fuel and dual fuel modification - Merits and demerits performance characteristics and their comparison.

UNIT-IV

Hydrogen Energy: Properties of Hydrogen, sources of Hydrogen, Thermodynamics of water splitting Production of Hydrogen, Electrolysis of water. Thermal decomposition of water. Thermo-chemical production, Biochemical production.

UNIT-V

Hydrogen fuel, Storage and Transportation methods, Applications to engines modifications necessary, precautions and safety measures - Performance characteristics in Engine and their comparison.

UNIT-VI

Electric Automobiles: Design considerations, limitations, opportunities for improvement Batteries, problems, future possibilities , capacities, types , material requirement, Applicability of electric cars, comparative use of fuel and energy. Availability of energy for recharging, impacts on use of fuel and energy .impact on urban air quality, impact on price, material requirement Traction motors and types.

UNIT-VII

Vegetable Oils: Various vegetable oils for engines-Esterification-Performance in engines-Performance and emission characteristics.

UNIT-VIII

Use of gas turbines in cars, arrangement, control merits and de- merits. Design of turbochargers for automobiles, their usefulness on the performance.

Text Books:

1. G.D. Rai "Non-conventional sources of energy Khanna Lab.
2. William Hamilton 'Electric Automobiles', PHI

Reference Books:

1. S.P. Sukhatme 'Solar Energy', Tata McGraw Hill
2. .S. Rao & B.B. Larulekar 'Energy Technology', Khanna Lab
3. Frank Kreith & Jan F. Krieder¹ Principles of Solar Engineering¹ McGraw Hill.
4. J.A. Duffie&W.A. Beckman 'Solar Energy -thermal Process' McGrawHill
5. T.N. Veziroglu. Alternative energy sources.

EAU 053 VEHICLE DYNAMICS

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3 1 0**

Objectives: To impart knowledge of vibrations due to different aspects like road construction and vibration measuring techniques to the students

UNIT-I

Undamped free vibration: Single degree of freedom Systems, introduction, undamped free vibration -Natural frequency' of free vibration, Rayleigh's method, stiffness of spring elements, effects of spring mass, Energy method, Newton's method and D' Alembert' s principle- problems.

UNIT-II

Damped free vibration: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, response study of viscous damped systems for cases of under damping and over damping, logarithmic decrement

UNIT-III

Forced vibration: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force solution by complex algebra, concept of response, reciprocating and rotating unbalance, vibration isolation Transmissibility ratio, energy dissipated by damping equivalent. viscous damping. Structural damping, sharpness or resonance, base excitation.

UNIT-IV

Vibration measuring instruments -Accelerometers and vibrometers. whirling of shafts with and without air damping, discussion of speeds above and below critical speeds

UNIT-V

Systems with two degree of freedom : Introduction, principle modes and normal modes" co-ordinate coupling, generalised and principle co-ordinate, free vibrations in terms of natural conditions. Lagranges equation, semi-definite systems, forced oscillations, harmonic excitation.

UNIT-VI

Vehicle vibrations: Vehicle vibration with single degree of freedom free vibration, forced vibration, vibration due to road roughness, vibration due to engine unbalance, transmissibility of engine mounting vibration with two degree of freedom, free vibration, compensated suspension systems forced vibration, vibration due to road roughness.

UNIT-VII

Different types of tyres - Materials used: Tyre construction, physics of tyre traction on dry and wet surface, tyre traction on dry and wet surface, tyre forces and moments, SAE recommended terminologies of tyre road interaction.

UNIT-VIII

Numerical methods for multi degree of freedom systems: Introduction, influence coefficients, Maxwell's reciprocal theorem, Dunkerley's equation, orthogonality principle, method of matrix iteration- method of determination of all the natural frequencies using sweeping matrix and orthogonality principle, Holzer's method for systems with free, fixed free and fixed ends.

TEXTBOOKS;

1. Mechanical Vibration -By O.K. Grover, Nemchand & Brothers
2. Vibration Theory & Applications -By William I Thomson, Prentice Hall
3. Theory & Problems of Mechanical Vibration -By William W. Seto, McGrawHill(sehauNTs outline series)
4. Problems in Automobile Mechanics-By N.K.Giri, Khanna Pub.
5. Mechanics of Pneumatic Tyre -By S.K.Cfark, Prentice Hall
6. Mechanical Vibration Analysis -By PSrinivasan, TMH

Prerequisites: Engineering mechanics, Mechanics of Solids, theory of machines

Department Elective-VI

EAU 061 COMPUTER SIMULATION OF IC ENGINES PROCESS

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Unit I

INTRODUCTION

Introduction - Heat of reaction - Measurement of URP - Measurement of HRP - Adiabatic flame temperature: Complete combustion in C/H/O/N Systems, Constant volume adiabatic combustion, constant pressure adiabatic combustion. Calculation of adiabatic flame temperature - Isentropic changes of state.

Unit II

SI ENGINE SIMULATION WITH AIR AS WORKING MEDIUM

Deviation between actual and ideal cycle - Problems, SI engine simulation with adiabatic combustion. temperature drop due to fuel vaporization, full throttle operation - efficiency calculation, part-throttle operation, super charged operation.

Unit III

PROGRESSIVE COMBUSTION

SI Engines simulation with progressive combustion with gas exchange process, Heat transfer process, friction calculation, compression of simulated values, validation of the computer code, engine performance simulation, pressure crank angle diagram and other engine performance.

Unit IV

SIMULATION OF 2-STROKE SI ENGINE

Simulate the performance, unbalanced forces on two stroke engine.

Unit V

DIESEL ENGINE SIMULATION

Multi zone model for combustion, different heat transfer models, equilibrium calculations, simulation of engine performance, simulation for pollution estimation.

References:

1. Ganesan.V. " Computer Simulation of spark ignition engine process ", Universities Press (I) Ltd, Hyderabad, 1996.
2. Ramoss.A.L., " Modelling of Internal Combustion Engines Processes ", McGraw Hill Publishing Co., 1992.
3. Ashley Campbel, " Thermodynamic analysis of combustion engines ", John Wiley & Sons, New York, 1986.
4. Benson.R.S., whitehouse.N.D., " Internal Combustion Engines ", Pergamon Press, oxford, 1979.

UNIT-I**Introduction**

Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Different approaches in Finite Element Method - Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus - Euler Lagrange equation, Rayleigh Ritz method, Weighted Residual methods, Point Collocation method, Galarkin method - Steps involved in FEM.

UNIT-II**Types of Elements Used**

Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two-dimensional elements, triangular and rectangular elements - Local and Natural Co-ordinate systems.

UNIT-III**Finite Element Formulation of Field Problems**

1-D and 2-D heat transfer, fluid flow (incompressible and non viscous fluid) in ducts, Simple electrical and magnetic field problems. Simple Numerical examples

UNIT-IV**Finite Element Formulation of Solid Mechanics Problems**

1-D problem of shaft; Truss element analysis of pinned truss, Plane stress/strain problems, Axisymmetric problems, thin plate problems; Vibration of shafts & beams.

UNIT-V**Numerical Methods in FEM**

Evaluation of shape functions - One dimensional & triangular elements, Quadrilateral elements, Isoperimetric elements - Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations – Gauss Elimination Method, Cholesky decomposition.

Books:

1. The Finite Element Method O.C. Zienkiewicz and R.L. Taylor McGraw Hill
2. An Introduction to Finite Element Method J. N. Reddy McGraw Hill
3. Finite Element Procedure in Engineering Analysis K.J. Bathe McGraw Hill
4. Finite Element Analysis C.S. Krishnamoorthy Tata McGraw Hill
5. Concepts and Application of Finite Element Analysis R.D. Cook, D.S. Malcus and M.E. Plesha John Wiley
6. Introduction to Finite Elements in Engineering T.R Chandragupta and A.D. Belegundu Prentice Hall India
7. Finite Element and Approximation O.C. Zenkiewicy & Morgan –
8. Numerical Methods E Balagurusamy Tata McGraw Hill

OBJECTIVE:

The course aims to make student understand the structure and the properties of the fluid. To understand and appreciate the complexities involved in solving the fluid flow problems. To understand the mathematical techniques already in vogue and apply them to the solutions of practical flow problems. To understand the energy exchange process in fluid mechanics handling incompressible fluids.

UNIT-I**BASIC CONCEPT & PROPERTIES**

Fluid - definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressure measurements by manometers and pressure gauges.

UNIT-II: FLUID KINEMATICS AND FLUID DYNAMICS

Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net. Equations of motion- Euler's equation along a streamline - Bernoulli's equation - applications - venturi meter. Orifice meter, other flow measurement instruments, Pilot Tube.

UNIT-III**DIMENSIONAL ANALYSIS**

Dimensional numbers, their application. - Buckingham's theorem - applications - similarity laws and models.

UNIT-IV: INCOMPRESSIBLE FLUID FLOW

Viscous flow-Navier- Stoke's equation (Statement only) - Shear stress, pressure gradient relationship laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - flow through pipes - Darcy - weisback's equation - pipe roughness - friction factor - Mody's diagram - minor losses - flow through pipes in series and in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

UNIT-V**HYDRAULIC TURBINES^HYDRAULIC PUMPS, COMPRESSOR & FANS**

Impact of jet on flat, curved & moving plates -Fluid machines: definition and classification exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagram's - head and specific work - component of energy transfer - degree of reaction.

Pumps: definition and classifications - Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves - reciprocating pump: classification, working principles, indicator diagram., work saved by air vessels and performance curves - cavitations in pumps rotary pumps: working principles of gear and vane pumps. Definition - Classification difference, efficiency, performance curves special application in Auto mobile Industries.

TEXTBOOKS

1. Fluid Mechanics and Hydraulics Machines (5th edition) by Bansal, R.K, Laxmi Publications (P) Ltd., New Delhi, 1995.
2. Fluid Mechanics by Streeter, V.L. and Wylie, E.B, McGraw-Hill, 1983
3. Hydraulic Machines- Theory and Design by Vasaadani, V.P., Khanna Publishers, 1992

REFERENCE BOOKS

1. FLUIDMECHANICS&MACHINES,BYD.S.KUMAR,KATARIAPUB.
2. Fluid Mechanics by White, EM., Tata McGraw-Hill, 5* Edition, New Delhi, 2003

List Of Open Elective for B.Tech. Courses

SCIENCE BASED OPEN ELECTIVE

EOE-031 / EOE-041	Introduction to soft Computing (Neural Network, Fuzzy Logic and Genetic Algorithm)
EOE-032 / EOE-042	Nano Sciences
EOE-033 / EOE-043	Laser Systems and Applications
EOE-034 / EOE-044	Space Sciences
EOE-035 / EOE-045	Polymer Science & Technology
EOE-036 / EOE-046	Nuclear Science
EOE-037 / EOE-047	Material Science
EOE-038 / EOE-048	Discrete Mathematics
EOE-039 / EOE-049	AUTOMOTIVE CHASSIS, SUSPENSION AND TRANSMISSION

OPEN ELECTIVE-I

EOE-071	Entrepreneurship Development
EOE-072	Quality Management
EOE-073	Operation Research
EOE-074	Introduction to Biotechnology

OPEN ELECTIVE-II

EOE-081	Non Conventional Energy Resources
EOE-082	Nonlinear Dynamic system
EOE-083	Product Development
EOE-084	Automation & Robotics