BACHELOR OF TECHNOLOGY
CURRICULA & SYLLABI

Mechanical Engineering Department

ABOUT THE DEPARTMENT

The Department of Mechanical Engineering, established in the year 1962, is imparting quality education to the students in the field of Mechanical Engineering through its Undergraduate programme. The department has, over the years, established its reputation as an excellent center for imparting high quality technical education to B.Tech. students. Presently, the Department is also running M.Tech. programmes in "Computer Integrated Manufacturing" since 2000 and "Energy Technology and Management" since 2013 as well as regular Ph.D. programme under TEQIP & QIP/University schemes.

The department has highly qualified faculty members and technical supporting staff. The good numbers of alumni of the department are occupying high positions in Governments, Semi-Governments and Private organizations in the country as well as abroad. The department offers consultancy services to various industries and Government departments in and out of this region. The laboratories of the department are being updated from time to time so that they remain well equipped to cater to the Research and Development.

VISION

To become an Internationally Acclaimed Department of Higher Learning, Research, Innovation and Incubation in Mechanical Engineering by 2035.

MISSION

1. To provide quality education to the students in order to make them globally competitive Mechanical Engineers.
2. To enhance the skills of students using modern engineering tools and experimental techniques to solve real life mechanical engineering problems.
3. To make them work in groups with high level of societal, environmental and professional ethics with the self learning attitude.

4. To establish linkages with the Industries, R&D organizations and Educational institutions in India and abroad for excellence in teaching, research and innovation.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO) OF B.TECH. PROGRAMME

PEO-1. To prepare students in the area of mechanical engineering for successful careers in industries, academia and research organizations through state of the art education.

PEO-2. To provide students with a sound foundation in science and engineering fundamentals necessary to formulate, analyze and solve mechanical engineering problems and to prepare them for research activities.

PEO-3. To develop ability in the field of machine design, thermal engineering, manufacturing and industrial engineering so as to design and create novel products, processes and solutions for the real life problems.

PEO-4. To inculcate in students professional and ethical attitude, effective communication & teamwork skills and ability to apply multidisciplinary knowledge to relate mechanical engineering problems to broader environmental and social context.

PEO-5. To engage students in professional development through the self learning and keep abreast with the state-of-the-art technology needed for a successful professional career.

PROGRAM OUTCOMES (POs) of B.Tech. PROGRAMME:

B.Tech. Mechanical Engineering students will demonstrate the ability to:

PO-1. Apply knowledge of mathematics, science and mechanical engineering fundamentals to solve real life problems.

PO-2. Identify, formulate, apply engineering knowledge, and conduct research to solve real life mechanical engineering problems.

PO-3. Ability to design a system, component or process by applying the knowledge of Machine Design, Thermal Engineering, Manufacturing to meet desired needs within realistic constraints such as economic, environment, cultural, societal, health and safety and sustainability.

PO-4. Ability to design and conduct experiments, as well as to analyze and interpret data and synthesis of information to reach out to solutions.

PO-5. Select, create and apply modern engineering and IT tools, including CAD, CAM to solve complex engineering problems.

PO-6. Apply reasoning to assess the impact of engineering solutions and practices in a global, societal, health, safety, legal and cultural context.

PO-7. Understand the impact of engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PO-8. Apply ethical principle, inculcate moral values and commit to professional ethics, responsibility and norms of engineering practice.

PO-9. Function effectively as member or leader in diverse teams and in multi-disciplinary settings.

PO-10. Communicate effectively on complex engineering activities with engineering fraternity and society at large such as being able to understand and write effective reports, documents, presentations and give and take instructions clearly.

PO-11. Apply knowledge and understanding of industrial engineering and management principles and function in multidisciplinary teams as a member or leader to manage projects.

PO-12. Recognition of the need for and an ability to engage in life-long self learning in state of the art technology.

PO-13. Ability to apply engineering fundamentals to design mechanical systems, thermal systems and manufacturing processes that leads to efficient production.

Credit Structure for B. Tech. Mechanical Engineering (ME)

(For newly admitted students from Session 2014-2015)

Category **Semesters**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Sciences & Maths (BSM)	14	9	9	5	-	-	-	-	**37**
Engineering Fundamentals (EF)	7	12	6	2	-	-	-	-	**27**
Department Core (DC)	-	-	8	14	20	22	10	5	**79**
Management (M)	-	-	-	3	3	-	-	-	**6**
Humanities & Social Science Core (HSSC)	-	4	-	-	-	-	-	-	**4**
Project (P)	-	-	-	-	-	-	5	5	**10**
Programme Electives (PE)	-	-	-	-	-	-	8/9	8	**16/17**
Open Electives (OE)	-	-	-	-	-	-	-	4	**4**
Humanities & Social Science Electives (HSSE)	3	-	-	-	-	-	-	-	**3**
Total	**24**	**25**	**23**	**24**	**23**	**22**	**23/24**	**22**	**186/187**

Curriculum for B. Tech. (Mechanical Engineering)

Freshman Year, Semester-I

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BAS-01	Engineering Mathematics-I	3	1	0	4
2.	BSM	BAS-02	Engineering Physics-I	3	1	2	5
3.	EF	BME-01	Engineering Mechanics	3	1	2	5
4.	HSSE	BAS-**	Humanities & Social Science Electives	2	1	0	3
5.	BSM	BAS-09	Engineering Chemistry	3	1	2	5
6.	EF	BCE-10	Engineering Graphics	0	0	4	2
7.	AC		Audit Course				-
			Total	**14**	**5**	**10**	**24**

Freshman Year, Semester-II

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BAS-07	Engineering Mathematics-II	3	1	0	4
2.	BSM	BAS-08	Engineering Physics-II	3	1	2	5
3.	HSSC	BAS-03	Professional Communication	3	1	0	4
4.	EF	BEE-01	Principles of Electrical Engineering	3	1	2	5
5.	EF	BCS-01	Introduction to Computer Programming	3	1	2	5
6.	EF	BME-10	Workshop Technology	0	0	4	2
7.	AC		Audit Course				-
			Total	**15**	**5**	**10**	**25**

Sophomore Year, Semester-III

S.N.	Category	Paper Code	Subject	L	T	P	Credits
1.	BSM	BAS-21	Engineering Mathematics-III	3	1	0	4
2.	BSM	BME-11	Material Science and Engineering	3	1	2	5
3.	EF	BME-12	Engineering Thermodynamics	3	1	0	4
4.	DC	BME-13	Measurement & Metrology	2	1	2	4
5.	DC	BME-14	Mechanics of Solids	3	1	0	4
6.	EF	BME-20	Mechanical Engineering Drawing	0	0	4	2
7.	AC		Audit Course				-
			Total	**14**	**5**	**8**	**23**

Sophomore Year, Semester-IV

S.N.	Category	Paper Code	Subject	L	T	P	Credits
1.	BSM	BAS-29	Numerical Methods	3	1	2	5
2.	M	MBA-01	Industrial Management	2	1	0	3
3.	DC	BME-16	Fluid Mechanics	3	1	2	5
4.	DC	BME-17	Kinematics of Machines	3	1	0	4
5.	DC	BME-18	Energy Conversion Systems	3	1	2	5
6.	EF	BAS-20	Communication Skills	0	0	4	2
7.	AC		Audit Course				-
			Total	**14**	**5**	**10**	**24**

Junior Year, Semester-V

S.N.	Category	Paper Code	Subject	L	T	P	Credits
1.	M	MBA-02	Engineering and Managerial Economics	2	1	0	3
2.	DC	BME-26	Machine Design-I	3	1	2	5
3.	DC	BME-27	Heat and Mass Transfer	3	1	2	5
4.	DC	BME-28	Dynamics of Machines	3	1	2	5
5.	DC	BME-29	Manufacturing Science	3	1	2	5
6.	AC		Audit Course				-
			Total	**14**	**5**	**8**	**23**

Junior Year, Semester-VI

S.N.	Category	Paper Code	Subject	L	T	P	Credits
1.	DC	BME-31	Machine Design-II	3	1	2	5
2.	DC	BME-32	Refrigeration & Air conditioning	3	1	2	5
3.	DC	BME-33	I C Engines and Compressors	3	1	0	4
4.	DC	BME-34	Machine Tools & Machining	3	1	0	4
5.	DC	BME-35	Principles of Industrial Engineering	3	1	0	4
6.	AC	BME-30	Seminar	0	0	6	-
			Total	**15**	**5**	**4**	**22**

Senior Year, Semester-VII

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	DC	BME-41	Automobile Engineering	3	1	2	5
2.	DC	BME-42	Computer Aided Design	3	1	2	5
3.	PE1	BME-**	Program Elective-1	3	1	0/2	4/5
4.	PE2	BME-**	Program Elective-2	3	1	0	4
5.	P	BME-40	Project Part-I	0	0	10	5
6.	AC	BME-45	Industrial/Practical Training	0	0	2	-
			Total	**12**	**4**	**14/16**	**23/24**

Senior Year, Semester-VIII

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	DC	BME-43	Computer Aided Manufacturing	3	1	2	5
2.	PE3	BME-**	Program Elective-3	3	1	0	4
3.	PE4	BME-**	Program Elective-4	3	1	0	4
4.	OE	BOE-**	Open Elective offered by other Department	3	1	0	4
5.	P	BME-50	Project Part-II	0	0	10	5
			Total	**12**	**4**	**12**	**22**

Engineering Fundamentals & Department Core (Mechanical Engineering)

S.N.	Paper Code	Subject	Prerequisite Subjects	L	T	P	Credits
		Year-I					
1.	BME-01	Engineering Mechanics	-	3	1	2	5
2.	BME-10	Workshop Technology	-	0	0	4	2
		Year-II					
3.	BME-11	Material Science and Engineering	-	3	1	2	5
4.	BME-12	Engineering Thermodynamics	-	3	1	0	4
5.	BME-13	Measurement & Metrology	-	2	1	2	5
6.	BME-14	Mechanics of Solids	-	3	1	2	5
7.	BME-16	Fluid Mechanics	-	3	1	2	5
8.	BME-17	Kinematics of Machines	-	3	1	0	4
9.	BME-18	Energy Conversion Systems	-	3	1	2	5
10.	BME-20	Mechanical Engineering Drawing	-	0	0	4	2
		Year-III					
11.	BME-26	Machine Design-I	BME-14	3	1	2	5
12.	BME-27	Heat and Mass Transfer	BME-12	3	1	2	5
13.	BME-28	Dynamics of Machines	-	3	1	2	5
14.	BME-29	Manufacturing Science	-	3	1	2	5
15.	BME-30	Seminar	-	0	0	6	3
16.	BME-31	Machine Design-II	BME-14	3	1	2	5
17.	BME-32	Refrigeration & Air conditioning	-	3	1	2	5
18.	BME-33	I C Engines	-	3	1	0	4
19.	BME-34	Machine Tools & Machining	-	3	1	0	4
20.	BME-35	Principles of Industrial Engineering	-	3	1	0	4
		Year-IV					
21.	BME-40	Project Part-I	-	0	0	10	5
22.	BME-41	Automobile Engineering	BME-33	3	1	2	5
23.	BME-42	Computer Aided Design	-	3	1	2	5
24.	BME-43	Computer Aided Manufacturing	-	3	1	2	5
25.	BME-45	Industrial/Practical Training	-	0	0	2	1
26.	BME-50	Project Part-II	BME-40	0	0	10	5

Programme Electives (Mechanical Engineering)

S.N.	Paper Code	Subject	Prerequisite Subjects	L	T	P	Credits
		PE1 & PE2 (VII Semester)					
1.	BME-51	Hydraulic Machines	BME-16	3	1	2	5
2.	BME-52	Principles of Machine Tools Design	-	3	1	0	4
3.	BME-53	Production Planning & Control	-	3	1	0	4
4.	BME-54	Industrial Tribology	-	3	1	0	4
5.	BME-55	Total Quality Management	-	3	1	0	4
6.	BME-56	Energy Management	-	3	1	0	4
7.	BME-57	Mechanical Vibrations	-	3	1	0	4
8.	BME-58	Renewable Energy systems	-	3	1	0	4
		PE3 & PE4 (VIII Semester)					
1.	BME-61	Power Plant Technologies	BME-12	3	1	0	4
2.	BME-62	Turbo Machinery	BME-12	3	1	0	4
3.	BME-63	Project Management	-	3	1	0	4
4.	BME-64	Advanced Welding Technology	-	3	1	0	4
5.	BME-65	Advanced Manufacturing Technology	-	3	1	0	4
6.	BME-66	Advanced Engineering Materials	-	3	1	0	4
7.	BME-67	Advanced Mechanics of Solids	BME-14	3	1	0	4
8.	BME-68	Gas Dynamics and Propulsion	-	3	1	0	4

Subjects offered for other departments

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	BME-02	Fundamentals of Mechanical Engineering	-	3	1	2	5
2.	BME-03	Manufacturing Processes	-	3	1	0	4
3.	BME-15	Engineering Materials	-	3	1	2	5
4.	BOE-16	Quality Management	-	2	1	0	3
5.	BOE-17	Reliability & Maintenance Engineering	-	2	1	0	3
6.	BOE-18	Industrial Pollution & Control	-	2	1	0	3

Audit Courses for B. Tech. (Mechanical Engineering)

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits

		Year-I					
1.	BAS-04	Environmental Chemistry	-	3	1	0	4
2.	BAS-05	Environment & Ecology	-	2	1	0	3
3.	BEC-01	Fundamentals of Electronics Engineering	-	3	1	2	5
4.	BAS-06	Space Sciences	-	2	1	0	3
		Year-II					
5.	BAS-22	Nano Technology	-	2	1	0	3
6.	BEE-16	Electromechanical Energy Conversion	-	3	1	2	5
7.	BEE-15	Introduction to Microprocessors	-	3	1	2	5
8.	MAS-109	Foreign Language-French	-	2	1	0	3
9.	MAS-110	Foreign Language-German	-	2	1	0	3
10.	MAS-111	Foreign Language-Spanish	-	2	1	0	3
		Year-III					
11.	BCS-73	Neural Network & Fuzzy Systems	-	3	1	0	4
12.	BCE-21	Environmental Impact Assessment & Management	-	3	1	0	4
13.	BCS-15	Database Management Systems	-	3	1	2	5

Humanities & Social Science Electives (Mechanical Engineering)

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	BAS-11	Human Values & Professional Ethics	-	2	1	0	3
2.	BAS-12	Industrial Psychology	-	2	1	0	3
3.	BAS-13	Industrial Sociology	-	2	1	0	3

Mechanical Engineering Department

Subject offered by the Department

S. N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	BME-01	Engineering Mechanics	-	3	1	2	5
2.	BME-02	Fundamentals of Mechanical Engineering	-	3	1	2	5
3.	BME-03	Manufacturing Processes	-	3	1	0	4
4.	BME-10	Workshop Technology	-	0	0	4	2
5.	BME-11	Material Science and Engineering	-	3	1	2	5
6.	BME-12	Engineering Thermodynamics	-	3	1	0	4
7.	BME-13	Measurement & Metrology	-	2	1	2	5
8.	BME-14	Mechanics of Solids	-	3	1	2	5
9.	BME-15	Engineering Materials	-	3	1	2	5
10.	BME-16	Fluid Mechanics	-	3	1	2	5
11.	BME-17	Kinematics of Machines	-	3	1	0	4
12.	BME-18	Energy Conversion Systems	-	3	1	2	5
13.	BME-20	Mechanical Engineering Drawing	-	0	0	4	2
14.	BME-26	Machine Design-I	BME-14	3	1	2	5
15.	BME-27	Heat and Mass Transfer	BME-12	3	1	2	5
16.	BME-28	Dynamics of Machines	-	3	1	2	5
17.	BME-29	Manufacturing Science	-	3	1	2	5
18.	BME-30	Seminar	-	0	0	6	3
19.	BME-31	Machine Design-II	BME-14	3	1	2	5
20.	BME-32	Refrigeration & Air conditioning	-	3	1	2	5
21.	BME-33	I C Engines	-	3	1	0	4
22.	BME-34	Machine Tools & Machining	-	3	1	0	4
23.	BME-35	Principles of Industrial Engineering	-	3	1	0	4
24.	BME-40	Project Part-I	-	0	0	10	5
25.	BME-41	Automobile Engineering	BME-33	3	1	2	5
26.	BME-42	Computer Aided Design	-	3	1	2	5
27.	BME-43	Computer Aided Manufacturing	BME-29	3	1	2	5
28.	BME-45	Industrial/Practical Training	-	0	0	2	1
29.	BME-50	Project Part-II	BME-40	0	0	10	5
30.	BME-51	Hydraulic Machines	BME-16	3	1	2	5
31.	BME-52	Principles of Machine Tools Design	-	3	1	0	4
32.	BME-53	Production Planning & Control	-	3	1	0	4

33.	BME-54	Industrial Tribology	-	3	1	0	4
34.	BME-55	Total Quality Management	-	3	1	0	4
35.	BME-56	Energy Management	-	3	1	0	4
36.	BME-57	Mechanical Vibrations	-	3	1	0	4
37.	BME-58	Renewable Energy systems	-	3	1	0	4
38.	BME-61	Power Plant Technologies	BME-12	3	1	0	4
39.	BME-62	Turbo Machinery	BME-12	3	1	0	4
40.	BME-63	Project Management	-	3	1	0	4
41.	BME-64	Advanced Welding Technology	-	3	1	0	4
42.	BME-65	Advanced Manufacturing Technology	-	3	1	0	4
43.	BME-66	Advanced Engineering Materials	-	3	1	0	4
44.	BME-67	Advanced Mechanics of Solids	BME-14	3	1	0	4
45.	BME-68	Gas Dynamics and Propulsion	-	3	1	0	4

SYLLABI

BME-01 ENGINEERING MECHANICS

Course category : Department Core (DC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits : 5
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the laws of mechanics and two-dimensional force systems, equivalent force system, types of friction and its application in belt drives.
2. The ability to draw shear force and bending moment diagrams for beams under concentrated and uniformly distributed loads; to determine centroid of plane composite surfaces; moment of inertia of composite bodies and mass moment of inertia of simple and complex shape bodies.
3. The ability to understand the relationships of kinetmatic quantities of rigid bodies involving linear, curvilinear and angular motions and kinetics of rigid bodies involving general motion and application of D'Alembert's principles.
4. Understand the effects of deformation, types of stress generation and relationships among

elastic constants, stresses in beams of different cross-sections in simple bending as well as stresses in circular shafts under pure torsion.

Topics Covered

UNIT-I

Two-dimensional Force Systems 9

Basic Concepts, Laws of Mechanics, System of forces, Varignon's theorem, Transfer of a force to parallel position, Equivalent force system, Resultant of concurrent and non-concurrent force system, Free body diagrams, Equations of equilibrium, Applications

Friction and Applications

Introduction, Dry friction, Rolling friction, Fluid friction, Laws of Coulomb friction, Angle of friction, Cone of friction, Angle of repose, Equilibrium of bodies involving dry friction, Bodies resting on rough horizontal and inclined planes, Belt friction-Flat and V belt, Ratio of driving tensions for flat belt, Centrifugal tension, Initial tension, Condition of maximum power transmission

UNIT-II

Beams 9

Introduction, Types of supports, Beams classification, Free body diagram, Shear force and bending moment, Analysis of beams, Continuous loading and discontinuous loading, Shear force and bending moment diagrams for concentrated and uniformly distributed loads

Properties of Plane Surfaces

First moment of area, Centroid of a plane and composite bodies joined by different surfaces, Surface of revolution and volume of revolution, Moment of Inertia of area, Parallel axis theorem, Perpendicular axis theorem, Moment of inertia of composite bodies, Principal axes and principal moments of inertia, Mass moment of inertia of a thin rod, thin uniform plate, thin rectangular sheet, circular ring, thin disc, solid cylinder, sphere and cone about their axis of symmetry

UNIT-III

Kinematics of a rigid body 9

Introduction, Plane motion of a rigid body, Linear motion, Translation of a point with constant acceleration, Equation of motion due to gravity, Angular motion, Relation between angular displacement and angular velocity with constant angular acceleration, Curvilinear motion of a particle, Normal and tangential acceleration, General plane motion, Instantaneous centre of rotation

Kinetics of rigid body

Introduction, Laws of motion, Kinetics of rigid bodies, Motion on inclined rough surface, Analysis of lift motion, Motion of two bodies connected by a string, Pure rotation of a rigid body, General motion of a rigid body, Work and energy, Linear and angular momentum, D'Alembert's principle

UNIT-IV

Mechanics of Deformable Bodies 9

Introduction, Normal and shear stresses, Poisson's ratio, Elastic constants and their relationships, Generalized Hooke's law, Deflection of bars of uniform and varying cross-sections, Strain energy in members due to static loading, Statically determinate problems, Stress-strain diagrams for ductile and brittle materials; Pure Bending of beams, Assumptions, Simple bending theory, Stress of beams of different cross sections ; Torsion of Circular shafts, Shear stress due to torsion, Polar modulus, Power transmission

EXPERIMENTS

Note: Minimum Eight experiments are to be performed

1. Tensile strength test on universal testing machine
2. Compressive strength test on universal testing machine
3. Impact test on Impact testing machine
4. Hardness testing of given specimen on Vicker/Brinell hardness testing machine
5. Torsion test of a rod on torsion testing machine
6. Determination of closed coil and open coil spring stiffness on spring testing machine
7. Experiments on friction between belt and pulley
8. Experiments on flywheel
9. Friction experiments on inclined plane/Screw jack
10. Experiments on bending of simple supported and cantilever beams
11. Statics experiments on equilibrium
12. Experiment on moment of inertia

Books & References

1. Engineering Mechanics: Statics and dynamics - I.H. Shames (PHI)
2. Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, F. P. Beer and E. R. Johnston (Tata McGraw Hill).
3. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II –Dynamics, J. L. Meriam and L. G. Kraige (John Wiley).
4. Engineering Mechanics: Principles of Statics and Dynamics R. C. Hibbler, (Pearson Press).
5. Engineering Mechanics -S S Bhavikatti (New Age International)
6. Engineering Mechanics - D S Kumar (Katson)
7. Engineering Mechanics, M. K. Harbola, (Cengage Learning)
8. Engineering Mechanics - H D Ram and A K Chauhan (McGraw Hill)
9. Engineering Mechanics- R. K. Bansal (Laxmi Publications)

BME-02 FUNDAMENTALS OF MECHANICAL ENGINEERING

Course category	:	For Other Department
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The knowledge of basic laws of thermodynamics; steam generation and its properties;

refrigeration cycles, properties and machines; and reciprocating machines such as two/four strokes IC engines.

2. The knowledge of measurement instruments, types of transducers for measurement of different geometrical parameters and ferrous and non-ferrous engineering materials.
3. The ability to understand different types of stresses, Hooke's law and its applications, different mechanical properties of engineering materials and skill of their testing on different machines.
4. The knowledge of different types of supports on beams, shear force and bending moment diagrams for statically determinate beams, stresses in simple bending of beams and torsion in circular shafts.

Topics Covered

UNIT-I 9

Thermodynamics

First and second law of thermodynamics, statements of Second Law of Thermodynamics and their equivalence, Third law of thermodynamics, Steam properties, Steam processes at constant pressure, volume, enthalpy and entropy, Classification of steam boilers, Efficiency and performance analysis, Refrigeration, Vapour compression and vapour absorption cycles, Coefficient of performance (COP), Refrigerant properties

Reciprocating Machines

Steam engines, hypothetical and actual indicator diagrams, Carnot cycle, Otto and Diesel cycles, Working of two and four strokes petrol and diesel IC engines.

UNIT-II 9

Measurement & Metrology

Introduction to measurement and measuring instruments, Types of sensors, Types of transducers and their characteristics, Measurement error and uncertainty analysis, Temperature, pressure, velocity, flow, strain, force and torque measurement, Measurement by dial gauges, slip gauges and sine bar

Engineering Materials

Classification, Ferrous and non ferrous metals, Composition of cast iron and carbon steel, mechanical properties, alloy steel and mechanical properties, Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications.

UNIT-III

Simple Stress and Strain 9

Introduction, Normal and shear stresses, Poisson's ratio, Elastic constants and their relationships, Generalized Hooke's law, Deflection of bars of uniform and varying cross-sections, Strain energy in members due to static loading, Statically determinate problems, Stress-strain diagrams for ductile and brittle materials

Mechanical Properties and Testing

Toughness, Hardness, Fracture, Fatigue and Creep, Strength and deformation testing, Bend/rebend testing, Hardness testing, Impact testing, Fatigue testing and creep testing, spring stiffness testing

UNIT-IV 9

Beams

Introduction, Types of supports, Beams classification, Free body diagram, Shear force and bending moment, Analysis of beams, Continuous loading and discontinuous loading, Shear force and bending moment diagrams for statically determinate beams

Pure Bending of beams

Introduction, Assumptions, Simple bending theory, Stress of beams of different cross sections

Torsion of Circular shafts

Introduction, Torsion of circular shafts, Shear stress due to torsion, Polar modulus, Power transmission

EXPERIMENTS

Note: Minimum Eight experiments are to be performed

1. Tensile strength test on universal testing machine
2. Compressive strength test on universal testing machine
3. Experiment on bend/rebend testing machine
4. Impact test on Impact testing machine
5. Hardness testing of given specimen on Vicker/Brinell hardness testing machine
6. Torsion test of a rod on torsion testing machine
7. Determination of closed coil and open coil spring stiffness on spring testing machine
8. Study of two stroke and four stroke engine
9. Study of slider crank mechanism
10. Experiment on fatigue testing machine
11. Experiments on bending of simple supported and cantilever beams
12. Study of steam boilers
13. Study of domestic refrigerator

Books & References

1. Basic and Applied Thermodynamics-P. K. Nag (Tata McGraw Hill)
2. Applied Thermodynamics-Onkar Singh (New Age International)
3. Elements of Materials science and Engineering-Van Vlash (Jhon Wiley & Sons)
4. Material Science-V. Raghvan (Prentice Hall India Limited)
5. Mechanical Measurement-G. Beckwith Thomas (Narosa Publishing House)
6. Mechanical Measurement – Sirohi (New Age Publications)
7. Strength of Materials-S. Ramamurtham (Dhanpat rai Publishing Co.)
8. Strength of Materials-R. K. Rajput (S. Chand)
9. Strength of Materials–R. K. Bansal (Lakshmi Publications)

BME-03 MANUFACTURING PROCESSES

Course category : For Other Department
Pre-requisite Subject : NIL
Contact hours/week : Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, attendance, home

methods		assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The students will be able to understand the basic manufacturing processes and different types of mechanical properties of ferrous, non-ferrous metals and alloys.
2. The basic knowledge of different forming and casting processes and foundry tools used for the manufacturing of different products.
3. The knowledge of different machine tools and machining processes, welding processes and their applications.
4. The knowledge of sheet metal processes and their applications, powder metallurgy process, basic heat treatment processes, nonmetallic materials and features of manufacturing establishment.

Topics Covered

UNIT-I

Introduction 9

Introduction and importance of Manufacturing processes, classification and overview of Manufacturing processes.

Mechanical Properties of Materials

Strength, elasticity, plasticity, stiffness, malleability, ductility ,brittleness, malleability, toughness hardness, resilience, hardness, machine ability, formability, weldability, Elementary ideas of fracture fatigue & creep.

Steels and Cast Irons

Carbon steels, their classification based on percentage of carbon as low, mild, medium & high carbon steel, their properties & applications. Wrought iron, Cast iron. Alloy steels: stainless steel, tool steel.

Alloys of Non Ferrous Metals

Common uses of various non-ferrous metals (Copper, Zink, Tin, Magnesium, Lead, Aluminum etc.) & alloys and its composition such as Cu-alloys: Brass, Bronze, Al-alloys

UNIT-II

Forming Processes 9

Hot-working & cold-working, Basic metal forming operations & uses of such as: Forging, Rolling, Wire & Tube drawing and Extrusion, and their uses.

Press-work: Die & Punch assembly, cutting and forming, its applications.

Casting

Pattern making, Materials, pattern making tools, pattern types and allowances. Type and composition of Molding sands and their desirable properties. Foundry tools, Mould making with the use of a core. Gating system. Casting defects & remedies. Cupola Furnace. Brief description of various types of casting processes.

UNIT-III

Machining 9

Lathe-machine: principle, types, main parts, specifications and operations performed on it., Basic description of machines and operations of Shaper-Planer, Drilling, Milling & Grinding.

Welding

Introduction, classification of welding processes. Gas-welding, types of flames and their applications. Electric-Arc welding. Resistance welding. Soldering & Brazing processes and their uses.

UNIT-IV

Sheet Metal Work 9

Tools and equipments used in sheet metal work, metals used for sheets, standard specification for sheets, Types of sheet metal operations: shearing, drawing, bending

Powder Metallurgy

Introduction of powder metallurgy process: powder production, blending, compaction, Sintering

Heat Treatment Processes

Introduction to Heat- treatment of carbon steels: annealing, normalizing, quenching, tempering and case-hardening, Introduction to Galvanizing and Electroplating.

Non-Metallic Materials

Common types & uses of Wood, Cement-concrete, Ceramics, Rubber, Plastics and Composite-materials

Manufacturing Establishment

Plant location. Plant layout–its types. Types of Production. Production versus Productivity.

Books & References

1. Workshop Technology Vol-I-B. S. Raghubanshi (Dhanpat Rai and Sons)
2. Workshop Technology Vol-II-B. S. Raghubanshi (Dhanpat Rai and Sons)
3. Production Technology - R.K. Jain (Khanna publication
4. Manufacturing Processes- H. N .Gupta, R. C. Gupta, Arun Mittal (New Age publisher)
5. Manufacturing Science -Ghosh and Mallik (EWP)
6. Manufacturing processes – Santosh Bhatnagar (B S publication)
7. Production Technology – P. C. Sharma (S. Chand)
8. Manufacturing Technology – Machine Tools- P. N. Rao (TMH)
9. Manufacturing Technology – Foundry, Forming and Welding- P. N. Rao (TMH).
10. Manufacturing Engineering & Technology- Kalpakjian (Pearson)

BME-10 WORKSHOP TECHNOLOGY

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 4
Number of Credits	:	2
Course Assessment Methods	:	Continuous assessment through three Viva voce, Practical work/record, attendance and Major Practical Examination

Course Outcomes : After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes

1. Understand the importance, materials, applications and safety in different shops for the development of a product/component.
2. The knowledge of tools and processes used in carpentry and foundry shops for the development of products through casting process.
3. The knowledge of forming process will develop skills for producing products using different tools and processes in black smithy and sheet metal shops.
4. The knowledge of tools and processes in machine shop and welding shop will develop ability of producing different products.

Topics Covered

Note: Make at least one job in each shop

1. **Introduction**
   - Need and importance of workshop
   - Mechanical properties of metals
   - Ferrous Metals and alloys- composition and applications
   - Non-Ferrous Metals and alloys- composition and applications
   - Safety in each shop
2. **Carpentry Shop:**
   - Draw layout of carpentry shop
   - Study of tools & operations and carpentry joints.
   - Preparation of half-lap corner joint, mortise & tennon joint
   - Simple exercise on woodworking lathe
3. **Fitting Shop:**
   - Layout of fitting shop
   - Study of tools & operations
   - Simple exercises involving fitting work.
   - Simple exercises involving drilling/tapping/die
4. **Black Smithy Shop:**
   - Layout of Smithy Shop
   - Study of tools & operations
   - Hot and cold working
   - Simple exercises base on black smithy operations such as upsetting, drawing down, punching, bending, fullering & swaging.
5. **Welding Shop:**
   - Layout of welding shop
   - Study of equipment of gas welding & arc welding
   - Preparation of simple butt and lap welded joints.
   - Oxy-acetylene flame cutting
6. **Sheet-metal Shop:**

- Layout of Sheet metal shop
- Metals used in sheet metal work such as Galvanized iron, Copper sheet, Aluminum sheet
- Study of tools & operations
- Fabrication of Funnel, tool-box, tray, electric panel box etc.

7. **Machine Shop:**
   - Layout of Machine shop
   - Study of Lathe, Drilling, Shaper, Planer and Milling Machines and commonly done operations on these machines
   - Single point and Multi-point Cutting tools
   - Making a job on lathe involving plane turning step turning, taper turning, and threading operations
8. **Foundry Shop:**
   - Layout of foundry shop
   - Study of tools & operations
   - Study on pattern allowances
   - To prepare a mould with the use of a core and cast it
   - Study of casting defects

BME-11 MATERIAL SCIENCE AND ENGINEERING

Course category	:	Basic Science & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the importance of numerous materials with their basic concepts including crystallography and imperfections.
2. The understanding about the advanced materials testing by different testing methods such as strength, hardness, fatigue, NDT, etc.
3. The knowledge of different surface behavior studies of engineering materials including heat treatment processes, TTT diagram and other related processes.
4. The knowledge of different concepts regarding materials and electrical, magnetic, electronic, etc. properties.

Topics Covered

UNIT-I 9

Introduction

Historical perspective, importance of materials, Crystallography and imperfections: Concept of unit cell, space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices, X-ray crystallography techniques, imperfections, Defects & Dislocations in solids

UNIT-II 9

Mechanical Properties and Testing

Stress strain diagram, Ductile and brittle materials, stress Vs strength, toughness, hardness, fracture, fatigue and creep. Testing, such as Strength testing, Hardness testing, Impact tests, Fatigue testing Creep testing, Non-destructive testing (NDT). Performance of materials in service: Brief theoretical consideration of fracture, fatigue, and corrosion and its control.

Micro Structural Examination

Microscope principle and methods, Preparation of samples and microstructure exam and grain size determination, comparative study of microstructure of various metals and alloys, such as Mild steel, CI, Brass.

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.

UNIT-III 9

Ferrous & Non-ferrous materials

Iron and steel manufacture, 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.

Non-Ferrous metals and alloys

Non-ferrous metals, such as Cu, Al, Zn, Cr, Ni etc. and its applications

UNIT-IV 9

Magnetic properties

Concept of magnetism- Dia, para, ferro magnetic materials, Hysteresis, Soft and hard magnetic materials, Magnetic Storages.

Electrical Properties

Energy band, concept of conductor, insulator and semi conductor. Intrinsic and extrinsic semi-conductors, P-n junction and transistors, Basic devices and their applications. diffusion of Solid, Super conductivity and its applications, Messier effect. Type I & II superconductors. High Temp. superconductors

Brief description of other material such as optical and thermal materials, Composite Materials and its uses. Smart materials & Nano-materials and their potential applications

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following:

1. Tensile test on universal testing machine
2. Compressive on universal testing machine
3. Torsion test of a rod on torsion testing machine
4. Creep test on creep testing machine
5. Fatigue test on fatigue testing machine
6. Hardness testing of given specimen on Vicker/Brinell/Rockwell hardness testing machine
7. Determination of deflection of cantilever under point/uniformly distributed loading
8. Determination of deflection of beam under point/uniformly distributed loading
9. Study of corrosion and its effects.
10. Comparative study of microstructures of different specimens of different materials (mild steel, gray C.I., brass, copper etc.)
11. Study of heat treatment processes such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after heat treatment.
12. Study of non destructive testing methods such as ultrasonic flaw detector, magnetic flaw detector and eddy current testing machine

Books & References

1. Material Science and Engineering – Smith, Hashemi and Prakash (Tata McGraw Hill)
2. Material Science- Narula (Tata McGraw Hill)
3. Material Science for Engineering Students- Fischer (Academic Press)
4. Material Science & Engineering - Van Vlash (John Wiley & Sons)
5. Elements of Material Science & Engineering -W.D. Callister (Wiley India Pvt. Ltd.)
6. Technology of Engineering Materials- Philip and Bolton (Butterworth-Heinamann)
7. Material Science -V. Raghvan (Prentice Hall of India)
8. Elements of Material Science & Engineering- Van Vlack (Pearson)

BME-12 ENGINEERING THERMODYNAMICS

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The basic understanding of the nature of the Thermodynamic processes for pure substances and ideal gases and ability to demonstrate the Zeroth law and First Law of

Thermodynamics.

2. Ability to apply the First Law of Thermodynamics for control surface and control volume systems and demonstrate the Second Law of Thermodynamics and its application to various systems.
3. Students will demonstrate ability to use the Second Law of Thermodynamics for entropy balance analysis of different Thermodynamics processes of systems and control volume.
4. Ability to demonstrate the various plots pertaining to properties of steam and Thermodynamic cycles and the working of IC Engines.

Topics Covered

UNIT-I 9

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.

Zeroth law of thermodynamics

Zeroth law of thermodynamics, Temperature and its' measurement, Temperature scales

First law of thermodynamics-I

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

UNIT-II 9

First law of thermodynamics-II

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

Second law of Thermodynamics

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 it's corollaries, thermodynamic temperature scale, PMM-II

UNIT-III 9

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.

Availability and Irreversibility

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

UNIT-IV 9

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 it's measurement, processes involving steam in closed and open systems, Simple Rankine cycle

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

Books & References

1. Engineering Thermodynamics - P.K. Nag (Tata McGraw Hill)
2. Fundamentals of Thermodynamics – Sonntag (Wiley India Pvt. Ltd)
3. Fundamentals of Classical Thermodynamics - Van Wylen (John Wiley & sons)
4. Thermodynamics - J.P. Holman (McGraw Hill)
5. Engineering Thermodynamics - Jones and Dugans (PHI Learning Pvt. Ltd)

BME-13 MEASUREMENT & METROLOGY

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding of measurement and measuring instruments, sensors and transducers, signal transmission and processing.
2. The knowledge of time related measurements, measurements of pressure, strain, temperature, force, torque, acceleration and vibration.

3. The knowledge of standards of linear measurement, line and end standards, limit fits and tolerances, interchangeability and standardization, linear and angular measuring devices and systems, comparators, limit gauges and gauge design.
4. The knowledge of measurement of geometric forms like straightness, flatness, roundness, tool maker's microscope, profile project autocollimator, Interferometry, Measurement of screw threads, gears and surface texture.

Topics Covered

UNIT-I 6

Mechanical Measurements

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.

Sensors and Transducers

Types of sensors, types of transducers and their characteristics

Signal transmission and processing

Devices and systems, Signal Display & Recording Devices

UNIT-II 6

Time related measurements

Counters, stroboscope, frequency measurement by direct comparison, Measurement of displacement

Measurement of pressure

Gravitational, directing acting, elastic and indirect type pressure transducers

Strain measurement

Types of strain gauges and their working, strain gauge circuits, temperature compensation

Measurements of force and torque

Different types of load cells, elastic transducers, pneumatic& hydraulic systems

Temperature measurement

Thermometers, bimetallic thermocouples, thermistors and pyrometers

UNIT-III 6

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

UNIT-IV 6

Metrology-II

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

Measurement and Inspection

Dimensional inspection–Tolerance, Limit gauging, comparators, Surface roughness, Feature inspection

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following:

1. To measurement of strain (gauge) through MS flat iron with help of Digital Strain indicator.
2. Measurement of displacement using linear variable differential transducer (LVDT)
3. To determine the temperature of bulb filament with the help of partial radiation pyrometer
4. To demonstrate the application of the law of intermediate Temperature
5. To measure the diameter of 'GO' and 'NOT GO Ends of a plug gauge with the help of micrometer and to determine the tolerance provide.
6. To measure the amount of clearance provided in the given fit with the help of dial caliper
7. To measuring the included angle of given hexagonal/ octagonal piece with the help of venire bevel protractor and to verify the same using the formula.
8. To measure the taper angle of given with the help of slip gauges and sine bar.
9. To measure the effective diameter of a screw thread using three wire method of a 1" BSW tap and find the flomle angle.
10. To study and sketch of tool mater microscope for measurement of dimensional parameters of the given work piece

Books & References

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

BME-14 MECHANICS OF SOLIDS

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The ability to determine stresses in beams and shafts under different loading conditions; understand Hooke's law and different theories of failure criteria.

2. The ability to calculate deflections in beams under different support conditions, deflection in helical and leaf springs under different loading conditions.
3. The ability to determine stresses in thin and thick cylindrical and thin spherical shells, and buckling loads in long columns under different support conditions.
4. The ability to determine stresses in curved beams and location of neutral axis, stresses and deflections in beams of different cross-sections subjected to unsymmetrical bending.

Topics Covered

UNIT-I 9

Compound stress and theory of failure

Introduction, Stresses due to different types of loads, Principal planes and principal stresses, Mohr's stress circle, Combined bending and torsion, Strain energy due to principal stresses, Energy of distortion and dilatation, Generalized Hooke's law, Theory of failure

Stresses in beams and circular shafts

Review of pure bending, combined direct and bending stresses, shear stresses in beams, Review of torsion, combined bending and torsion of solid and hollow circular shafts

UNIT-II 9

Deflection of beams

Equation of elastic curve, Cantilever and simply supported beams, Mecaulay's method, Area moment method, Fixed beam carrying point load and uniformly distributed load, continuous beams, Clapeyron's theorem, Castgliano's theorem

Helical and Leaf springs

Helical springs under axial loads and axial twist, Deflection of spring by energy method, Open and closed coil helical springs under axial and twist loadings, Semi-elliptical laminated spring

UNIT-III 9

Thin cylindrical and spherical shells

Hoop and axial stresses and strain, Design of cylindrical shell, Cylindrical shell with hemispherical ends, Volumetric strain, Wire wound cylinders, spherical shell

Thick cylindrical shell

Stresses in thick cylinders subjected to internal or external pressures, Design of thick cylindrical shell, Compound cylinders, Stresses due to interference fits

Columns and Struts

Classification, Euler's theory for long column for different end conditions, Limitations, Rankine formulae for struts/columns

UNIT-IV 9

Curved Beams

Bending of beams with large initial curvature, Position of neutral axis for rectangular, circular, triangular and trapezoidal cross-sections, Stresses in crane hooks and circular rings under tension and compression

Unsymmetrical bending and Shear centre

Stresses due to unsymmetrical bending, Deflection of beams due to unsymmetrical bending, Determination of shear centre and flexural axis for I-section and channel section

Books & References

1. Introduction of Mechanics of Materials – I.H. Shames
2. Strength of Materials-S. Ramamurtham (Dhanpat Rai Publishing Co.)
3. Strength of Materials-R. K. Rajput (S. Chand)
4. Strength of Materials-Ryder (Mcmillan Publishers India Limited)
5. Strength of Materials-Timoshenko and Young (Tata McGraw Hill)
6. Advanced Mechanics of Solids-L S Srinath (Tata McGraw Hill)
7. Mechanics of Solids – Egor P. Popov (Pearson)
8. Mechanics of materials-Pytel (CL Engineering)

BME-15 ENGINEERING MATERIALS

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The importance of numerous materials with their basic concepts including crystallography and imperfections.
2. The understanding about the advanced materials testing by different mechanical testing methods such as strength testing, hardness, fatigue, NDT, etc.
3. Different surface behavior studies of engineering materials including heat treatment processes, TTT diagram and other related processes.
4. Different concepts regarding materials and electrical, magnetic, electronic, etc. properties.

Topics Covered

UNIT-I 9

Introduction

Importance of materials, Brief review of modern & atomic concepts in Physics and Chemistry. Atomic models

Crystalline nature of solids

Crystal system unit cell space lattice, Bravais lattices, common crystal structures, Atomic packing

factor and density. Miller indices, Imperfections, Defects & Dislocations in solids

UNIT-II 9

Mechanical properties and Testing

Stress strain diagram for Ductile & brittle material, Toughness, Hardness, Fracture, Fatigue and Creep. Testing of materials such as Strength tests, Hardness tests, Impact tests, Fatigue tests, Creep tests, Cold and Hot working of metals and their effect on mechanical properties.

Phase Diagram and Equilibrium Diagram

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

UNIT-III 9

Ferrous & Non-ferrous material

Various types of carbon steels, alloy steels and cast irons, its properties, uses and applications, Heat Treatment: Various types of heat treatment processes such as Annealing, Normalizing, Quenching, Tempering, and various case hardening processes. Time Temperature Transformation (TTT) diagrams. Diffusion: Diffusion of Solids, Fick's I and II law.

Non-Ferrous metals and alloys

Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and its applications

UNIT-IV 9

Dielectric & Magnetic properties

Dielectric Materials and their applications, Concept of magnetism- Dia, para, ferro magnetic materials, Hysteresis, Soft and hard magnetic materials, Magnetic Storages

Electronic Properties

Energy band, concept of conductor, insulator and semi conductor. Intrinsic and extrinsic semi-conductors, P-n junction and transistors, Basic devices and their applications. Bragg's law, Messier effect. Type I & II superconductors. High Temp. superconductors. Brief description of other material such as optical and thermal materials, Composite Materials and its uses, Smart materials & Nano-materials and their potential applications

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following:

1. Tensile test on universal testing machine
2. Compressive on universal testing machine
3. Torsion test of a rod on torsion testing machine
4. Creep test on creep testing machine
5. Fatigue test on fatigue testing machine
6. Hardness testing of given specimen on Vicker/Brinell/Rockwell hardness testing machine
7. Determination of deflection of cantilever under point/uniformly distributed loading
8. Determination of deflection of beam under point/uniformly distributed loading
9. Study of corrosion and its effects.
10. Comparative study of microstructures of different specimens of different materials (mild steel, gray C.I., brass, copper etc.)
11. Study of heat treatment processes such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after heat treatment.
12. Study of non destructive testing methods such as ultrasonic flaw detector, magnetic flaw detector and eddy current testing machine

Books & References

1. Material Science and Engineering – Smith, Hashemi and Prakash (Tata McGraw Hill)
2. Material Science- Narula (Tata McGraw Hill)
3. Material Science for Engineering Students- Fischer (Academic Press)
4. Material Science & Engineering - Van Vlash (John Wiley & Sons)
5. Elements of Material Science & Engineering -W.D. Callister (Wiley India Pvt. Ltd.)
6. Technology of Engineering Materials- Philip and Bolton (Butterworth-Heinamann)
7. Material Science -V. Raghvan (Prentice Hall of India)
8. Elements of Material Science & Engineering- Van Vlack (Pearson)

BME-16 FLUID MECHANICS

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The fundamental concepts of fluid mechanics and knowledge of fluid and its properties,

types of fluid flows, 3D fluid flow, etc.

2. The knowledge of parameters of fluid statics, pressure transducers and pressures on plane and curved surfaces, stability of immersed and floating bodies.
3. Understand the various aspects of Laminar and Turbulent Flow.
4. The ability to carry out dimensional analysis and control volume analysis in fluid mechanics.

Topics Covered

UNIT-I 9

Introduction

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

Kinematics of Fluid flow

Types of fluid flows: Continuum & 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

UNIT-II 9

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.

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, notches and weirs, momentum equation and its application to pipe bends.

UNIT-III 9

Laminar and Turbulent Flow

Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, 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.

UNIT-IV 9

Dimensional Analysis and Hydraulic Similitude

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

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.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following:

1. To verify the momentum equation using the experimental set-up on impact of 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 and study the variation of the co-efficient of discharge with the Reynolds number.
4. To calibrate a Venturimeter and study the variation of the co-efficient of discharge with the Reynolds number.
5. To calibrate a bend meter and study the variation of the co-efficient of discharge with the Reynolds number. .
6. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
7. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
8. To study the variation of friction factor, 'f' for turbulent flow in commercial pipes.
9. To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.
10. To determine Meta-centric height of a given ship model.
11. To determine the head loss for a sudden enlargement
12. To determine the head loss for a sudden Contraction

Books & References

1. Introduction of fluid mechanics & Fluid Machines - Som, S.K. & Biswas G. (TMH, 2000, 2e)
2. Fluid Mechanics & Turbomachines -M M Das (Oxford University Press)
3. Fluid Mechanics & Machinery - S.K. Agarwal (TMH)
4. Fluid Mechanics through Problems - Garde, R.J. (New Age International Pvt. Ltd, 2e)
5. Mechanics of Fluids -I.H. Shames (McGraw Hill, Int. Student, Education, 1988)
6. Fluid Mechanics - Jagdish Lal (Metropolitan Book Company)
7. Elementary Mechanics of Fluids -Hunter Rouse (John Wiley & Sons Omc. 1946)

BME-17 KINEMATICS OF MACHINES

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The knowledge of kinematic links, its classification and applications in different planar mechanisms and machines, and ability to determine kinematic quantities in different planar mechanisms.
2. The knowledge of different types of mechanisms consisting of lower pairs, and kinematic synthesis of slider crank mechanism and four bar mechanism.
3. The knowledge of gear tooth profiles, terminology, law of gearing and calculation of minimum number of teeth to avoid interference and study different types of gear trains for power transmission
4. The knowledge of different types of cams and followers motions, cam profile generation techniques for different types of follower motion, and analytical methods of cam design

Topics Covered

UNIT-I 9

Introduction

Links-types, Kinematics pairs-classification, Constraints-types, Degrees of freedom of planar mechanisms, Grubler's equation, linkage mechanisms, inversions of four bar chain, slider crank chain and double slider crank chain

Velocity in Mechanisms

Relative velocity method, Velocities in four bar mechanism, slider crank mechanism and quick return motion mechanism, Instantaneous center method, Types & location of instantaneous centers, Kennedy's theorem, Velocities in four bar mechanism & slider crank mechanism

Acceleration in Mechanisms

Acceleration of a point on a link, Acceleration diagram, Coriolis component of acceleration, Klein's construction for four bar mechanism and slider crank mechanism

UNIT-II 9

Mechanisms with Lower Pairs

Pantograph, Exact straight line motion mechanisms-Peaucellier's, Hart and Scott Russell mechanisms, Approximate straight line motion mechanisms–Grass-Hopper, Watt and Tchebicheff mechanisms

Kinematic Synthesis of Planar Linkages

Graphical method-Two and Three position synthesis of four bars and slider crank mechanisms, Analytical method-Freudenstein's equation, Slider crank mechanism, Classification of synthesis problem, Precision points for function generation

UNIT-III 9

Gears

Classification & terminology, Law of gearing, Tooth forms & comparisons, Systems of gear teeth, Contact ratio, Interference & under cutting in involute gear teeth, Minimum number of teeth on gear and pinion to avoid interference

Gear Trains

Simple, Compound, Reverted and epicyclic gear trains, Sun and planet gear

UNIT-IV 9

Cams

Cams and Followers-Classification & terminology, Follower motion-Uniform velocity, Simple harmonic motion and Uniform acceleration and retardation, Cam Profile, Graphical Methods-Radial cam, Knife edge, roller and flat face followers, Analytical methods of cam design – tangent cam with reciprocating roller follower and circular arc cams with flat faced follower

Books & References

1. Theory of Machines-S.S. Rattan (Tata McGraw Hill)
2. Theory of Machines and Mechanisms-Ghosh & Mallik (East West Press)
3. Theory of Machines and Mechanisms- Shigley (McGraw Hill)
4. Theory of Machines and Mechanisms- Rao & Dukkipati (New Age International)
5. Theory of Machines - Thomas Bevan (Pearson Education)
6. Theory of Machines – Malhotra & Gupta (Satya Prakasan, Tech. India)

BME-18 ENERGY CONVERSION SYSTEMS

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the general principles of mass and energy conservation, thermodynamic relations; ability to analyze combustion of fuels, heat reaction and calculation, study different types of condensers and its performance parameters.
2. The knowledge of different types of boilers, their mountings and accessories, heat balance and different types of vapor power cycles
3. Study steam engines and applications of steam in steam and gas nozzles, different types of steam turbines and related parameter calculations.
4. The knowledge of principles and working of gas turbines, actual and ideal gas turbine cycles, jet propulsion and introduction to rocket engine.

Topics Covered

UNIT-I 9

Thermodynamic relations

Conditions for exact differentials, Maxwell relations, Clapeyron equation, Joule-Thompson coefficient and Inversion curve. Coefficient of volume expansion, Adiabatic and Isothermal compressibility

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. Condenser: Classification of condenser, air leakage, condenser performance parameters

UNIT-II 9

Boilers

Classifications and working of boilers, boiler mountings and accessories, Draught and its calculations, air pre heater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation, Boiler trial and heat balance

Vapour Power cycles

Carnot vapour power cycle, Rankine cycle, effect of pressure and temperature on Rankine cycle, reheat cycle, Regenerative cycle, Feed water heaters, Binary vapour cycle, Combined cycles, Cogeneration.

UNIT-III 9

Steam Engines

Modified Rankine cycles, working and classification of steam engines, Indicator diagram, Saturation curve, Missing quantity, Heat balance

Steam and Gas Nozzles

Flow through Convergent and convergent-divergent nozzles, 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.

Steam Turbines

Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine.

UNIT-IV 9

Gas Turbines

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.

Jet Propulsion

Introduction to the principles of jet propulsion, Turbojet and turboprop engines and their processes, Principle of rocket propulsion, Introduction to Rocket Engine.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the 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

Books & References

1. Basic and Applied Thermodynamics - P.K. Nag (TMH)
2. Applied Thermodynamics for Engineering Technologists- Eastop (Pearson Education)
3. Applied thermodynamics - Onkar Singh (New Age International)
4. Applied Thermodynamics - Venkanna & Swati (PHI)
5. Thermodynamics and Energy Systems Analysis - Borel and Favrat (CRC Press)
6. Mechanics and Thermodynamics of Propulsion - Hill and Peterson (Pearson Education)
7. Gas turbine Theory & Practice - Cohen & Rogers (Addison Wesley Long man)

BME-20 MECHANICAL ENGINEERING DRAWING

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 4
Number of Credits	:	2
Course Assessment methods	:	Continuous assessment through three Viva, Practical work/record, attendance and Major Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand layout of drawing sheet, IS codes, scales, different types of lines, section lines, dimensioning, etc.
2. The orthographic projections of simple solids; drawings of parts of temporary fastener, i.e., nuts and bolts and permanent fasteners, i.e., riveted joints and its applications to boiler joint.
3. The knowledge of assembly drawing of cotter joint, knuckle joint, stuffing box, etc. and production drawing of simple machine components

4. The knowledge of basic commands and development of drawings of simple solids in AutoCAD software and free hand sketching of machine components.

Topics Covered

UNIT-I

Introduction (1 drawing sheet) 8

Graphics Language, Classification of machine drawings, Layout of drawing sheet, IS codes, Scales, Lines, Section lines, Dimensioning

Orthographic Projections (2 drawing sheets) 8

Introduction, Principles of first angle and third angle projection, Orthographic views, Drawing of machine elements in first angle projection, Selection of views, Sectional views, Missing views

Fasteners Drawing (2 drawing sheets) 8

Temporary fasteners-Screw threads nomenclature, Bolts and nuts

Permanent fasteners-Rivets and riveting, Types of rivet heads, Types of riveted joints, Boiler joint

Assembly Drawing (2 drawing sheets) 8

Assembly drawing of cotter joint, knuckle joint, stuffing box, cross head, pedestal bearing, eccentric, lathe tail stock, screw jack, safety valve etc.

Production Drawing (1drawing sheet) 4

Types, Use of different symbols such as machining, surface roughness symbols etc, Examples of simple machine elements gear, crank, jig, connecting rod, pulley, piston etc

Computer Aided Drafting (2 drawings) 8

Introduction to drafting software like AutoCAD, Basic commands and development of 2D and 3D drawings of simple parts

Free hand sketching* 4

Introduction, Need for free hand sketching,

Draw free hand sketching of the following machine components on sketch book

1. Conventional representations of engineering materials
2. Locking arrangements of nuts
3. Types of foundation bolts
4. Types of studs
5. Types of pulleys
6. Types of keys
7. Rigid coupling or Flexible coupling
8. Types of Welded symbols
9. Surface Roughness nomenclature, machining symbols, indication of surface roughness

Note: **Students are required to submit the free hand sketching assignment at the end of the semester*

Books & References

1. Machine Drawing - KL Narayana, P Kannaiah, KV Reddy (New Age)
2. Machine Drawing - PS Gill (SK Kataria & Sons)
3. Machine Drawing -N. Siddeshswar, 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)

BME-26 MACHINE DESIGN-I

Course category	:	Department Core (DC)
Pre-requisite Subject	:	Mechanics of Solids (BME-14)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The understanding of design of mechanical components/systems, associated design parameters and standards, and knowledge of engineering materials and their properties.
2. The ability to design mechanical components under the static loads and dynamic loads based on different criteria.
3. The ability to design temporary and permanent joints such as riveted, bolted and welded joints as well as design of cotter and knuckle joints and its engineering applications.
4. The knowledge of design of circular shafts under the combined loadings, selection of keys, and design of rigid & flexible couplings.

Topics Covered

UNIT-I

Introduction 9

Definition, Design requirements of machine elements, General design procedure, Introduction to Design for Manufacturing, Interchangeability, Limits, Fits and Tolerances, Standards in design, Selection of preferred sizes

Engineering materials and their properties

Classification, Mechanical properties, Ferrous and non-ferrous metals, Non metallic materials, Indian Standards designation of carbon & alloy steels, Selection criteria of materials

UNIT-II

Design under Static Load 9

Modes of failure, Factor of safety and basis of determination, Principal stresses, Torsional and

bending stresses, Principal stresses in design of machine element, Theory of failure, Eccentric loading

Design under Variable Loads

Cyclic stresses, Fatigue and endurance limit, Factors affecting endurance limit, Stress concentration factor, Stress concentration factor for machine components, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria

UNIT-III

Design of Joints 9

Design of threaded joints, Preload on the bolt, stiffness of bolt and members, efficiency of joints; Design of weld joints, Specification of welds, weld design under different loading conditions, Design of riveted joints.

Cotter and Knuckle Joint

Types of cotter joints, Design of socket and spigot cotter joint, Gib and cotter joint, Design of knuckle joint

UNIT-IV

Design of Shafts 9

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

Keys and Couplings

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

Note: Design data book is allowed in Minor/Major Examinations

EXPERIMENTS

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

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

Books & References

1. Mechanical Engineering Design – Joseph E. Shigely (McGraw Hill)
2. Mechanical Design of Machine Components – Norton (Prentice Hall)
3. Fundamentals of Machine Components Design – Juvinall (Wiley)
4. Design of Machine Members - Alex Valance and VI Doughtie (McGraw Hill)
5. Machine design-M.F. Spott (Prentice Hall India)

6. Machine Design-Maleev and Hartman (CBS)
7. Machine design -Black & Adams (McGraw Hill)
8. Machine Design-Sharma and Agrawal (S.K. Katara & Sons)
9. Design of Machine Elements-V.B. Bhandari (Tata McGraw Hill)

BME-27 HEAT AND MASS TRANSFER

Course category	:	Department Core (DC)
Pre-requisite Subject	:	Engineering Thermodynamics (BME-12)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the basic laws of heat transfer and steady state one-dimensional heat conduction for different co-ordinate systems.
2. The knowledge of application of fins for enhancing the heat transfer rate and natural heat convection over the surfaces of different shapes.
3. The understanding of concepts and estimation of heat transfer under the forced convection, condensation and boiling phenomenon on surfaces and pipes and able to design the different types of heat exchangers.
4. The understanding of concepts and analysis of thermal radiation and its numerical solutions and introduction to mass transfer.

Topics Covered

UNIT-I

Introduction to Heat Transfer 9

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

Conduction

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

Steady State one-dimensional Heat conduction

Composite Systems in rectangular, cylindrical and spherical coordinates without energy generation;

Thermal resistance concept; Analogy between heat and electricity flow; Thermal contact resistance; Critical thickness of insulation. Concept of overall heat transfer coefficients.

UNIT-II

Fins 9

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

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.

UNIT-III

Forced Convection 9

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; Empirical heat transfer relations; Flow inside ducts; Relation between fluid friction and heat transfer.

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, Heat pipes; Boiling modes, pool boiling

Heat Exchanger

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

UNIT-IV

Thermal Radiation 9

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

Introduction To Mass Transfer

Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film

EXPERIMENTS

Minimum Eight experiments are to be conducted from 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.

Books & References

1. Elements of Heat Transfer - Bayazitouglu & Ozisik (McGraw-Hill)
2. Heat Transfer - J.P. Holman (McGraw-Hill International)
3. Schaum's outline of Heat Transfer - Pitts & Sisson (McGraw-Hill International)
4. Principles of Heat Transfer - Frank Kreith (McGraw-Hill Book)
5. Heat Transfer - Vijay Gupta (New Age International (P) Ltd.)
6. Heat Transfer -Y.V.C. Rao (University Press)
7. Heat Transfer - R. Yadav (Central Publishing House)
8. Fundamentals of heat transfer – Incropera, Dewitt (Wiley)
9. Heat Transfer - D S Kumar (S Chand)

BME-28 DYNAMICS OF MACHINES

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The students will be able to carry out static and dynamic force analysis of four bars mechanism and slider crank mechanism, and study different types of turning moment diagrams and design of flywheels.
2. The knowledge of different types of centrifugal governors, the effects of characteristic parameters and controlling force diagrams for governors, understand the principles of gyroscopic effect and its engineering applications.
3. Understand the balancing of several rotating masses, primary and secondary unbalanced forces in reciprocating engines and ability to analyze single degree freedom systems subjected to free, damped and forced vibrations as well as calculation of critical speeds

of shaft under different support conditions.

4. Understand the basics laws of friction and its engineering applications in pivot and collar bearings, clutches, shoe brake, band and block brakes, and absorption and transmission type dynamometers.

Topics Covered

UNIT-I

Static & Dynamic Force Analysis 9

Static equilibrium of two/three force members, Static equilibrium of member with two forces and torque, Static force analysis of linkages, D'Alembert's principle, Equivalent offset inertia force, Dynamic force analysis of four link mechanism and slider crank mechanism, Dynamically equivalent system

Turning Moment & Flywheel

Engine force analysis-Piston and crank effort, Turning moment on crankshaft, Turning moment diagrams-single cylinder double acting steam engine, four stroke IC engine and multi-cylinder steam engine, Fluctuation of energy, Flywheel and its design

UNIT-II

Governors 9

Terminology, Centrifugal governors-Watt governor, Dead weight governors-Porter & Proell governor, Spring controlled governor-Hartnell governor, Sensitivity, Stability, Hunting, Isochronism, Effort and Power of governor

Gyroscopic Motion

Principles, Gyroscopic torque, Effect of gyroscopic couple on the stability of aero planes & automobiles

UNIT-III

Balancing of Machines 9

Static and dynamic balancing, Balancing of several masses rotating in the same plane and different planes, Balancing of primary and secondary forces in reciprocating engine, Partial balancing of two cylinder locomotives, Variation of tractive force, swaying couple, hammer blow, Balancing of two cylinder in-line engines

Mechanical Vibrations

Types of vibrations, Elements of vibrating system, Classification, Degrees of freedom, Single degree free & damped vibrations of spring-mass system, Logarithmic decrement, Torsional vibration, Forced vibration of single degree system under harmonic excitation, Critical speeds of shaft

UNIT-IV

Friction 9

Laws of friction, Efficiency on inclined plane, Screw friction, Screw jack, Efficiency, Friction in journal bearing-friction circle, Pivots and collar friction-Flat and conical pivot bearing, Flat collar bearing

Clutches, Bakes & Dynamometers

Single and multiple disc friction clutches, Cone clutch, Brakes-types, Single and double shoe brake, Simple and differential Band brake, Band and Block brake, Absorption and transmission dynamometers, Prony brake and rope brake dynamometers

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following

1. Experiments on simple and dead weight governor
2. Experiment on spring controlled governor
3. Experiment on gyroscope
4. Experiment on critical speed of shaft
5. Experiment on longitudinal vibration
6. Experiment on transverse vibration
7. Experiment on static/dynamic balancing
8. Experiment on Gear trains
9. Experiment on Gears tooth profile, interference etc.
10. Study of simple linkage models/mechanisms
11. Study of inversions of four bar linkage
12. Study of inversions of single/double slider crank mechanisms
13. Experiment on Brake
14. Experiment on clutches/dynamometers
15. Experiments on friction

Books & References

1. Theory of Machines - Thomas Bevan (CBS Publication)
2. Theory of Machines and Mechanisms- Shigley (Oxford University Press-New Delhi)
3. Theory of Machines and Mechanisms-Ghosh & Mallik (East West Press)
4. Theory of Machines and Mechanisms- Rao & Dukkipati (Wiley)
5. Theory of Machines - S.S. Rattan (Tata McGraw Hill)
6. Theory of Machines – R.K. Bansal (Laxmi)
7. Mechanics of Machines – V. Ramamurti (Alpha Science Intl Ltd.)
8. Theory of Machines – Khurmi & Gupta (S Chand)
9. Theory of Machines – P.L. Ballaney (Khanna)
10. Theory of Machines – V. P. Singh (Dhanpat Rai publisher)

BME-29 MANUFACTURING SCIENCE

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to understand the fundamentals and analysis of Forging and Rolling processes.
2. Knowledge of wire drawing, extrusion, sheet metal working, and unconventional metal forming process such as explosive forming and electromagnetic forming.
3. Know about principles, working and applications of various types of welding processes and their thermodynamic and metallurgical aspects.
4. Able to understand pattern allowances, moulding sand properties, elements of mould and casting processes.

Topics Covered

UNIT-I

Introduction 9

Importance of manufacturing, economic & technological considerations in manufacturing, classification of manufacturing processes, materials & manufacturing processes for common items

Metal forming processes-1

Elastic & plastic deformation. Tresca's & Von Mises' Yield's criteria. Hot & cold working processes. Analysis 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. Analysis of Rolling Process. Condition for rolling force and power in rolling. Rolling mills & rolled-sections

UNIT-II

Metal forming processes-11 9

Analysis of Wire/strip drawing and maximum-reduction, Tube drawing, Extrusion and its application. Design, lubrication and defects in metal forming processes.

Sheet metal working:

Presses and their classification Die & punch assembly and press work methods and processes. Cutting/Punching mechanism, Blanking & piercing. Compound & progressive dies. Flat-face & Inclined-face punches and load calculation. Analysis of forming process like cup/deep drawing. Bending & spring-back.

Unconventional metal forming processes

Unconventional metal forming or High Energy Rate Forming (HERF) processes — explosive forming, electromagnetic, electro-hydraulic forming.

UNIT-III

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 — atomic hydrogen, submerged arc, electroslag, friction. Soldering & Brazing. Thermodynamic and Metallurgical aspects in welding. Shrinkage/residual stress in welds. Defects in welds and their remedies. Weld decay in Heat affected zone (HAZ). 9

UNIT-IV

Casting (Foundry) 9

Basic principle & survey of casting processes. Types of patterns and allowances. Types and

properties of moulding sand, sand testing. Design considerations for elements of mould—Gate, Riser, Runner & Core. Solidification of casting. Sand casting— defects, remedies. Cupola furnace. Other casting processes— Die Casting, Centrifugal casting, Investment casting, Continuous casting and CO_2 casting etc.

Textbooks & Reference books

1. Manufacturing Science -Ghosh and Mallik (EWP)
2. Manufacturing Engineering & Technology- Kalpakjian (Pearson)
3. Materials and Manufacturing - Paul Degarmo. (TMH)
4. Manufacturing Technology – Foundry, Forming and Welding- P. N. Rao (TMH).
5. Manufacturing Processes Vol I – H. S. Shan (Pearson)
6. Fundamental of Modern Manufacturing – M. P. Groover (PHI)
7. Production Engineering Science - P.C. Pandey (Standard publisher)
8. Production Technology - R.K. Jain (Khanna publication)
9. Production Engineering – P. C. Sharma (S. Chand)
10. Workshop Technology Vol1-B. S. Raghubanshi (Dhanpat Rai and Sons)

BME-30 SEMINAR

Course category	:	Audit Course (AC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 6
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through quality of material, presentation, quality & extent of external response of question asked and participation in other seminars (attendance)
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to develop effective writing on recent technological development.
2. Ability to make effective presentation on power point.
3. Ability to comprehend question/answers during presentation.
4. Enhance oral communication skills.

BME-31 MACHINE DESIGN - II

Course category	:	Department Core (DC)
Pre-requisite Subject	:	Mechanics of Solids (BME-14)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2

Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The ability to deign different types of mechanical spring under static and fatigue loading, and knowledge of different types of screw threads and design of screw jack.
2. The knowledge of tooth forms, gear tooth materials, manufacturing methods and design of spur gear, helical gear and worm gear.
3. The knowledge of different parameters and selection criteria for the sliding contact bearing, rolling contact ball and roller bearing, its lubrication and mountings.
4. The knowledge of design considerations of IC engines parts and design of cylinder head, piston assembly, connecting rod and crankshaft.

Topics Covered

UNIT-I

Design of Mechanical Springs 9

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.

Power Screws

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

UNIT-II

Spur Gears 9

Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations as per AGMA, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

Helical and Worm Gears

Terminology, Proportions for helical gears, Beam strength and wear strength of helical gears, herringbone gears, crossed helical gears, Design of helical gears.

Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing

UNIT-III

Sliding Contact Bearing 9

Types, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing terminology, Bearing characteristic number, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing,

Rolling Contact Bearing

Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing

UNIT-IV

IC Engine Parts 9

Selection of type of IC engine, General design considerations, Design of Cylinder and cylinder head; Design of piston, piston ring and gudgeon pin; Design of connecting rod; Design of centre crankshaft

Note: Design data book is allowed in the Minor/Major Examination.

EXPERIMENTS

(i) Minimum Six 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

(ii) Mini Project: Students are required to write computer program and validate it for the design of at least two machine components studied in Machine Design-I and Machine Design-II theory subjects as home assignment which is be submitted at the end of the semester.

1. Design and drawing of helical spring subjected to static and fatigue loading
2. Design and drawing of screw jack
3. Generation of gear tooth profile
4. Design of spur gear drive
5. Design of helical gear drive
6. Design of worm and worm wheel
7. Design of journal bearing
8. Design of thrust bearing
9. Selection of ball and roller bearing
10. Design of cylinder and cylinder head
11. Design of piston assembly
12. Design of connecting rod
13. Design of crankshaft

Books & References

1. Mechanical Engineering Design – Joseph E. Shigely (McGraw Hill)
2. Mechanical Design of Machine Components – Norton (Prentice Hall)
3. Fundamentals of Machine Components Design – Juvinall (Wiley)
4. Design of Machine Members-Alex Valance and VI Doughtie (McGraw Hill)
5. Machine design-M.F. Spott (Prentice Hall India)
6. Machine Design-Maleev and Hartman (CBS)

7. Machine design -Black & Adams (McGraw Hill)
8. Machine Design-Sharma and Agrawal (S.K. Kataria & Sons)
9. Design of Machine Elements-V.B. Bhandari (Tata McGraw Hill)

BME-32 REFRIGERATION & AIR CONDITIONING

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the refrigeration principles, air refrigeration cycles and introduction to the different refrigerants.
2. Understand the knowledge of vapour compression refrigeration system and performance calculations.
3. Understand the knowledge of vapour absorption refrigeration systems and introduction to the psychrometry in air conditioning systems.
4. Understand the designing of air conditioning systems and introduction to various refrigerating equipment and its application.

Topics Covered

UNIT-I

Refrigeration 9

Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P.

Air Refrigeration cycle

Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system.

Refrigerants

Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, secondary refrigerants and CFC free refrigerants

UNIT-II

Vapour Compression System 9

Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system.

UNIT-III

Vapour Absorption system 9

Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram, Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium-
Bromide water vapour absorption system, Comparison

Air Conditioning-I

Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart. Cooling and heating load calculations

UNIT-IV

Air Conditioning-II 9

Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Introduction to desiccant cooling.

Refrigeration Equipment & Applications

Elementary knowledge of refrigeration & air conditioning equipments, e.g., compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. To study different types of expansion devices used in refrigeration system.
3. To study different types of evaporators used in refrigeration systems.
4. To study basic components of air-conditioning system.
5. Experiment on air-conditioning test rig & calculation of various performance parameters.
6. To study air washers
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compressor.
9. Visit of a central air conditioning plant and its detailed study.
10. Visit of cold-storage and its detailed study.
11. Experiment on Ice-plant.
12. Study of Hermetically sealed compressor

Books & References

1. Refrigeration and Air conditioning - Manohar Prasad (New Age International (P) Ltd)
2. Refrigeration and Air conditioning - C.P Arora (Tata McGraw Hill).

3. Refrigeration and Air conditioning - Arora & Domkundwar (Dhanpat Rai & Co.(p) Ltd, Delhi).
4. Refrigeration and Air conditioning - Stoecker & Jones (McGraw-Hill Education India Pvt.Ltd - New Delhi).
5. Principle of Refrigeration - Roy J. Dossat (Pearson).
6. Refrigeration and Air conditioning - P.L. Baloney (Khanna).
7. Thermal Environment Engineering - Kuhen, Ramsey & Threlkeld (Prentice Hall)
8. Performance studies of desiccant cooling systems - P. Rai, S.K. Shukla (Lambert publication Germany)

BME-33 IC ENGINES

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The importance & Classification of engine such as two & four stroke engines, SI & CI Engines and air standard cycles.
2. The knowledge of SI Engines, configuration & functions; knowledge about carburetor & its type and understand the ignition systems.
3. The knowledge of CI Engines, configuration, functions & fuel injections; Knowledge about knock & its control; knowledge about scavenging in two stroke engines, pollution& its control.
4. The knowledge of cooling systems and lubrication principle and its type in IC engines & also about Supercharging, compressors its type & principle of working.

Topics Covered

UNIT-I

Introduction to I C Engines 9

Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, Sterling cycle, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, stratified charge engine.

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.

UNIT-II

Testing and Performance of IC engines 9

Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines. Morse test, heat balance sheet, constant speed / variable speed test

SI Engines

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

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

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

UNIT-III

CI Engines 9

Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines, Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings. Scavenging in two Stroke engines, pollution and it's control.

UNIT-IV

Engine Cooling: Different cooling systems, Radiators and cooling fans. 9

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

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

Books & References

1. Fundamentals of Internal Combustion Engine - Gill, Smith, Ziurs (Oxford & IBH Publishing Co.)
2. IC Engines – Rogowsky (International Book Co.)
3. Internal Combustion Engine and Air Pollution- E.F Obert (Harper & Row, New York)
4. A Course in International Combustion Engines - Mathur & Sharma (Dhanpat Rai & Sons)
5. I.C Engine – Ganeshan (Tata McGraw Hill)
6. I.C Engine - R. Yadav (Central Publishing House)
7. Turbines, Compressors and Fans - S.M. Yahya (Tata McGraw Hill)
8. Fundamentals of Combustion – D. P. Mishra (PHI Leaning Pvt. Ltd.)

BME-34 MACHINE TOOLS & MACHINING

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to understand mechanics of metal cutting, lubricants, tool materials, economics of metal cutting, etc.
2. Study the principles, construction of various parts and working of different machine tools.
3. Able to understand the grinding and super finishing operations and concepts of Standardization & Interchangeability, Limits, Fits & Tolerance and Surface roughness
4. Understand principle and working of different non-conventional machining processes.

Topics Covered

UNIT-I

Metal Cutting 9

Mechanics of metal cutting. Geometry of tool and nomenclature. ASA system. Orthogonal/ 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. Economics of metal cutting

UNIT-II

Machine Tools: 9

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

UNIT-III

Grinding & Super finishing 9

Grinding: Grinding wheels, abrasives (bonds & cutting action). Grinding wheel specification. Wear of grinding wheel— dressing & truing, Max. chip thickness and Guest criteria. Surface and cylindrical grinding. Center less grinding.

Super finishing: Honing, lapping, and polishing.

Jigs & Fixtures

Locating & Clamping devices & principles. Jigs and fixtures and its applications.

Standardization & Interchangeability

Limits, Fits, Tolerance and Surface roughness

UNIT-IV

Unconventional Machining 9

Introduction. Limitations of conventional machining processes, need of Unconventional machining processes & their classifications. Principle, working and applications of Abrasive Jet Machining (AJM),Ultra sonic Machining (USM), Electro discharge machining (EDM), Electrochemical Machining (ECM), & Electron beam machining (EBM)

EXPERIMENTS

Minimum eight experiments are to be conducted from the following:

1. Design and Pattern making
2. Making a mould (with core) and casting.
3. Study & operation of hand & power forging.
4. Press work experiment such as blanking/piercing, washer, making etc.
5. Wire drawing/extrusion on soft material.
6. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine
7. Bolt (thread) making on Lathe machine
8. Gear cutting on milling machine
9. Machining a block on shaper machine
10. Study of different types of tools and its materials
11. Experiment on tool wear and tool life
12. Experiments on welding (Gas, Arc & resistance)
13. Experiment on unconventional machining

Books & References

1. Advanced Machining Process - VK Jain (Allied Publisher)
2. Fundamentals of Metal Cutting & Machine Tools – Juneja & Shekhon (New Age International)
3. Production Technology – P. C. Sharma (S. Chand)
4. Introduction to Machining Science – G. K. Lal (New Age Publisher)
5. Manufacturing Science - Ghosh and Mallik (EWP)
6. Manufacturing Technology : Metal Cutting & Machine Tools- P. N. Rao (TMH)
7. Production Engineering Science - P.C. Pandey (Standard Publisher)
8. Modern Machining Processes - P.C. Pandey & H.S. Shan (TMH)
9. Manufacturing Engineering & Technology- Kalpakjian (Pearson)
10. Production Technology - R.K. Jain (Khanna Publication)
11. Process & Materials of Manufacturing – Roy A. Lindburg (Prentice Hall)
12. Materials and Manufacturing - Paul Degarmo (TMH)
13. Workshop Technology Vol. II-B. S. Raghubanshi (Dhanpat Rai and Sons)

BME-35 PRINCIPLES OF INDUSTRIAL ENGINEERING

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the Concept, Function and Application of industrial engineering, production and productivity, measurement of productivity, work study, work sampling.
2. The knowledge of job evaluation and analysis, wage-incentive payment plans, materials Handling, Objectives and Functions of production planning and control, Break-Even-Analysis**.**
3. The understanding of depreciation, service life of assets, Inventory control, process control, Control Charts, acceptance plan and acceptance sampling.
4. Understand the Concept and importance of organization, organizational structure, Organizational chart, Sole/proprietary enterprise, labour legislation, factory act, wage and insurance act.

Topics Covered

UNIT-I

Introduction 9

Concept of Industrial Engineering, Function of industrial engineering, Industrial engineering techniques, Role of industrial engineer. Application of industrial engineering

Production and Productivity

Concept of production, production function, production system, definition of productivity, difference between productivity and production, productivity efficiency and effectiveness, measurement of productivity, Types of productivity, productivity index, ways to improve productivity.

Work study

Definition and concept, objectives of work study, purpose and procedure of method study, analysis of motion, micromotion study, motion economy principles, flow chart, man-machine chart, PMTS, work measurement, stop- watch time study, performance rating, standard time, work sampling.

UNIT-II

Job Evaluation & Merit rating 9

Concept of job evaluation, Job analysis, Job description, job simplification, job evaluation methods. Definition and methods of merit rating, wage-incentive payment plans.

Plant layout and materials Handling

Considerations in Plant location, definition of plant layout, types of layout, principles of Plant layout, material handling equipments

Production planning and control

Objectives of PPC, Functions of PPC, production planning, steps in PPC, Effectiveness of PPC system

Break-Even-Analysis

Introduction and purpose of BEA, Margin of safety, Angle of incidence, Profit volume graph.

UNIT-III

Depreciation and Replacement 9

Concept of depreciation, obsolescence, classification of depreciation, method of charging depreciation, service life of assets, Replacement of items.

Inventory Control

Inventory, function of inventory, inventory cost, deterministic inventory models

Statistical Quality Control

Introduction, process control, Control Charts, acceptance plan, acceptance sampling, single, double & sequential sampling plans, concept of average outgoing quality**.**

UNIT-IV

Organization 9

Concept and importance of organization**,** Principles of organization, organizational structure, Design of organization, Organizational chart.

Industrial Ownership

Sole/proprietary enterprise, partnership firm, Joint stock company, classification of company, comparison of public, private and joint sector, & co-operative organization.

Factory legislation in India

Importance and principles of labour legislation, factory act, payment of wages act, minimum wages act, workmen's compensation act, employee's state insurance act.

Books & References

1. Production Management- S. K. Hajara Choudhary, Nirjhar Roy and A. K. Hajara Choudhary (Media Promoters and Publisher)
2. Production and Operation Management - Adam and Ebert (Pearson Education Asia)
3. Modern Production/operations Management- Buffa (Wiley Eastern, New York).
4. Industrial Engineering and operations management- S.K. Sharma & Savita Sharma (SK Kataria & sons)
5. Industrial Engineering – A.P. Verma (SK Kataria & sons)
6. Industrial Engineering – M.I. Khan (New Age International)
7. Industrial Engineering – S. Seetharaman & B. Vijayaramnath (Umesh Publications)
8. Industrial Engineering and Management – O.P. Khanna (Dhanpat Rai Publications)

BMC-40 PROJECT PART-I

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 10
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through three viva voce/presentation, preliminary project report, effort and regularity and end semester presentation
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to apply engineering knowledge of different streams of mechanical engineering to finalize the project statement.

2. To carry out literature review of relevant project problem using textbooks, research papers and internet.
3. To finalize the activities to be carried out to complete the project through bar chart.
4. To plan different activities of project to develop a hardware or computer model

BME-41 AUTOMOBILE ENGINEERING

Course category	:	Department Core (DC)
Pre-requisite Subject	:	IC Engines (BME-33)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Good knowledge of automotive components and machineries and Ability to absorb the concerned problem at first instance and provide the suitable remedial measure to the problem.
2. Proficient in designing innovative projects and various transmission systems for fuel efficient engine.
3. Ability to demonstrate the various braking system, chassis and suspension system and electrical systems for automobiles like ignition, horn and battery.
4. Ability to demonstrate the fuel supply, air-conditioning, cooling and lubrication and maintenance systems for automobiles.

Topics Covered

UNIT-I

Power Unit and Gear Box 9

Principles of Design of main components. Valve mechanism. Power and Torque characteristics. Rolling, air and gradient resistance. Tractive effort. Gear Box. Gear ratio determination, Design of Gear box

UNIT-II

Transmission System 9

Requirements. Clutches. Torque converters. Over Drive and free wheel, Universal joint. Differential Gear Mechanism of Rear Axle. Automatic transmission, Steering and Front Axle.

Castor Angle, wheel camber & Toe-in, Toe-out etc. Steering geometry. Ackerman mechanism, Understeer and Oversteer.

Vehicle stability- Stability analysis of the Linearlized model of vehicle , stability on a curve

UNIT-III

Braking System 9

General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes, Hydraulic brakes. Vacuum and air brakes. Thermal aspects.

Chassis and Suspension System

Loads on the frame. Strength and stiffness. Various suspension systems.

Electrical System

Types of starting motors, generator & regulators, lighting system, Ignition system, Horn, Battery etc.

UNIT-IV

Fuel Supply System 9

Diesel & Petrol vehicle system such as Fuel Injection Pump, Injector & Fuel Pump, Carburetor etc. MPFI.

Automobile Air Conditioning

Requirements, Cooling & heating systems

Cooling & Lubrication System

Different type of cooling system and lubrication system

Maintenance system

Preventive maintenance, break down maintenance and over hauling.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. Study & experiment on Ignition system of I.C. Engine.
2. Study & experiment on Fuel Supply System of S.I. Engines- Carburettor, Fuel Injection Pump and MPFI.
3. Study & experiment on Fuel Supply System of C.I. Engines- Injector & Fuel Pump.
4. Study & experiment on Valve mechanism.
5. Study & experiment on Gear Box.
6. Study & experiment on Differential Gear Mechanism of Rear Axle.
7. Study & experiment on Steering Mechanism.
8. Study & experiment on Automobile Braking System.
9. Study & experiment on Chassis and Suspension System.
10. Study & experiment on Air Conditioning System of an Automobile.
11. Comparative study of technical specifications of common small cars (such as Maruti Swift, Hyundai i20, Cheverlet Aveo, Tata Indica, Ford Fusion etc.
12. Comparative study & technical features of common scooters & motorcycles available in India.
13. Visit of an Automobile factory.
14. Visit to a Modern Automobile Workshop.
15. Experiment on Engine Tuning.
16. Experiment on Exhaust Gas Analysis of an I.C. Engine
17. Determination of Indicated H.P. of I.C. Engine by Morse Test
18. Prepare the heat balance for Diesel Engine test rig
19. Prepare the heat balance sheet for Petrol Engine test rig

Books & References

1. Automotive Machines- Hietner (CBS Publisher)
2. Automobile Engineering - Kripal Singh (Standard).
3. Automobile Engineering – Narang (Khanna).
4. Automotive Mechanics- Crouse, Anglin (Career Education)
5. Motor Vehicle – Garrett, Newton and Steeds (Society of Automotive Engineers Inc).

BME-42 COMPUTER AIDED DESIGN

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The importance, benefits, applications and essential elements of CAD such as graphics input, display and output devices.
2. The knowledge of graphics software, graphics standards, configuration and functions; skill of writing algorithm for generating 2D graphic elements; and understand the mathematics behind 2D & 3D individual and combined geometric transformations.
3. The ability of mathematical representation of parametric form of analytic planar curves and synthetic space curves such as Hermite, Bezier and B-spline curves and knowledge of their properties.
4. The knowledge of polygonal, quadric and superquadric surfaces, blobby objects, color models and different solid modeling techniques and skill of developing 3D geometric models in CAD software.

Topics Covered

UNIT-I

Introduction 9

Computer in Engineering design, Classical vs. Computer Aided Design, Elements of CAD, Essential requirements of CAD, CAD Tools, Concepts of integrated CAD/CAM, Necessity & benefits, Engineering Applications

Computer Graphics Hardware

Graphics systems, Graphics Input devices-cursor control devices, Digitizers, Image scanner, Speech oriented devices, Graphics display devices-Cathode Ray Tube, Calligraphic display, DVST, Raster display, Color frame buffer, Color CRT monitors, Solid state monitors-emissive displays, non-emissive displays, Graphics output devices- Hard copy printers and plotters

UNIT-II

Computer Graphics Software 9

Graphics Software, Software Configuration, Coordinate system, Graphics software functions, Viewing transformations-windowing and clipping, Graphics software standards

Output primitives

Scan conversion of primitives, Line generation algorithms-DDA and Bresenham's line drawing algorithm, Circle generating algorithm-Cartesian coordinates, Polar coordinates and Bresenham's algorithm

Geometric Transformations

2D Geometric transformations-Translation, Scaling, Shearing, Rotation & Reflection Matrix representation-homogeneous coordinates, Rotation and scaling about arbitrary point, Reflection through arbitrary line, Composite transformation, 3 D transformations, multiple transformation

UNIT-III

Planar Curves 9

Curves representation, Interpolation vs approximation, Classical representation of curves, Parametric analytic curves-lines, circles, ellipses, parabolas and hyperbolas

Space Curves

Properties for curve design, Parametric continuity, Parametric representation of synthetic curves, , Spline curves and specifications, Parametric representation of synthetic curves, Hermite curves-Blending functions formulation, shape control, properties, Bezier curves-Blending functions formulation, properties, Non-rational B-spline curves- Blending functions formulation, knot vector, B-spline blending functions, properties

UNIT-IV

3D Graphics 9

Introduction, Wireframe modeling, Surface modeling, Polygon surfaces-polygon meshes, polygon equations, Quadric and Superquadric surfaces, Blobby objects, Solid modeling-Boolean set operations, regularized set operations, Primitive instancing, Sweep representation-translational, rotational and hybrid sweeps, Boundary representation-topology, geometry, boundary models, Constructive solid geometry-unbounded and bounded primitives

Color models

Coloring in computer graphics, RGB, CMY, YIQ, HSV and HLS color models

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. Understanding and use of drafting software AutoCAD
2. Sketching and solid modeling of a machine component in any CAD software
3. Sketching and solid modeling of machine assembly in any CAD software
4. Writing and validation of line drawing algorithm
5. Writing and validation of circle drawing algorithm
6. Writing and validation of computer program for individual 2D/3D Geometric Transformation

such as translation/ rotation/scaling

7. Writing and validation of computer program for 2D/3D Combined Geometric Transformations
8. Writing and validation of computer program for design of shaft under the combined bending and torsional loading
9. Writing and validation of a computer program for generating planar curves
10. Writing and validation of computer program for generating space curves

Books & References

1. Computer Graphics-Hearn & Baker (Prentice Hall of India)
2. Computer Aided Engineering Design-Anupam Saxena & B. Sahay (Anamaya Publishers)
3. CAD/CAM Theory and Practice- Ibrahim Zeid & R Sivasubramaniam (McGraw Hill)
4. Mathematical Elements for Computer Graphics- DF Rogers & JA Adams (McGraw Hill)
5. CAD/CAM-HP Groover & EW Zimmers, Jr (Prentice Hall India)
6. Computer Aided Design-S.K. Srivastava (IK International Publications)
7. Computer Aided Design-R.K. Srivastava (Umesh Publications)

BME-43 COMPUTER AIDED MANUFACTURING

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the role of computer in the areas of automation and manufacturing for improving their effectiveness and fundamentals of CNC machine tools.
2. Ability to develop manual part program and computer assisted part program for the production of components.
3. Ability to design and develop various systems such as feedback, interpolator, material handling and implementation of adaptive control.
4. Ability to apply the concept of group technology and computer assisted process planning and knowledge about Robotics.

Topics Covered

UNIT-I

Automation 9

Need of automation, basic elements of automation, levels of automation, automation strategies, advantages & disadvantages of automation, historical development and future trends, automated manufacturing system Introduction to computer integrated manufacturing (CAM).

Features of NC Machines

Fundamental of Numerical Control, elements of NC machine tools, classification of NC machine tools, Advantages, suitability and limitations of NC machine tools, Application of NC system, Methods for improving Accuracy considering the factors such as tool deflection and chatter, Methods for improving productivity.

UNIT-II

CNC Part Programming 9

Part programming fundamentals, Manual programming for drilling, turning and milling operations, canned cycles, Do loops, Subroutine, and Macros.

Computer aided part programming, APT programming. Geometry, Motion and additional statements, Macro- statement

UNIT-III

System Devices 9

Introduction to DC motors, stepping motors, feedback devices such as encoder, counting devices, digital to analog converter and vice versa.

Interpolators

Digital differential Integrator-Principle of operation, exponential decelarion, DDA
Hardware Interpolator- Linear, Circular; DDA Software Interpolator

Control of NC Systems

Open and closed loops. Control of point to point systems- Incremental open loop control, Incremental close loop, Absolute close loop; Control loop in contouring systems; Adaptive control.

UNIT-IV

Computer Integrated Manufacturing system 9

Group Technology, Flexible Manufacturing System, Computer aided process planning; Concept of Mechatronics, Computer aided Inspection.

Robotics

Types and generations of Robots, Structure and operation of Robot, Robot applications. Economics, Robot programming methods. VAL and AML (with examples)

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. To study the characteristics features of CNC lathe trainer.
2. To study the characteristics features of CNC Turning machine.
3. To study the characteristics features of CNC Milling machine.
4. To write Manual part program for a job for turning operation and prepare the component.
5. To prepare Manual part program for a job for drilling operation.
6. To write Manual part program for a job for milling operation and prepare the component.
7. Study of retrofitting.
8. Study of a pick and place robot.
9. Write a program for a pick and place robot to shift the work piece from one location to another.

10. To prepare a part program in APT for drilling operation.
11. To prepare a part program in APT for milling operation.

Books & References

1. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover (PHI)
2. Computer Aided Manufacturing - P. N. Rao , N. K. Tewari & T. K. Kundra (Tata McGraw Hill).
3. CAD/CAM/CIM – P. Radhakrishnan, S. Subrmanyam and V. Raju (New Age International)
4. Computer Aided Manufacturing – Chang, Wysk and Wang (Pearson)
5. Computer Control of Manufacturing systems – Koren (McGraw Hill)
6. Numerical control and Computer aided manufacturing- - P. N. Rao , N. K. Tewari & T. K. Kundra (Tata McGraw Hill)
7. Computer Aided Design & Manufacture – C. B. Besant & C. W. K. Lui (East West Press)
8. NC Machines – S. J. Martin (English Language Book Society)
9. CAD/CAM – Ibraheim Zeid (Tata McGraw Hill)
10. CAD/CAM- P. N. Rao (Tata McGraw Hill)
11. Principles of Computer Integrated Manufacturing – S. Kant Bajpai (PHI)

BME-45 INDUSTRIAL / PRACTICAL TRAINING

Course category	:	Audit Course (AC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 2
Number of Credits	:	1
Course Assessment methods	:	Continuous assessment through technical quality of the work, attendance, discipline, involvement and interest, project work, viva voce, project report and presentation
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. An ability to apply knowledge of mathematics, science and engineering in the development of product and process.
2. An ability to design and conduct experiments as well as to analyze and interpret data.
3. An ability to perform multidisciplinary task for the professional development in the field of engineering.
4. Ability to identify sources of hazards, and assess/identify appropriate health & safety measures
5. Ability to demonstrate the use, interpretation and application of an appropriate international engineering standard in a specific situation

BME-50 PROJECT PART-II

Course category	:	Department Core (DC)
Pre-requisite Subject	:	Project Part-I (BME-40)
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 10
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through three viva voce/presentation, final project report, contribution made to literary world and Major examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to design the various component/subsystem of project using basic and advanced knowledge of science and engineering subjects.
2. Able to analyse the various components/process of project problem.
3. Able to fabricate the hardware through different fabrication techniques available.
4. Able to make computer programme to design and analyse different components of product.
5. Able to make conclusion of given project.

BME-51 HYDRAULIC MACHINES

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	Fluid Mechanics (BME-16)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Define basic principles of operation of different types of Hydraulic Turbines and estimate hydrodynamics thrust of jet on fixed and moving plate.
2. Principles, construction, working and design of Francis Turbine and Kaplan Turbines,

and its performance characteristics.

3. Classification, Principles, construction, working and design of centrifugal pumps and its performance characteristics.
4. Principles, construction, working of positive displacement reciprocating and rotary pumps and basic aspects of its design. Principles, construction and working of hydraulic accumulator, hydraulic press, hydraulic lift cranes, hydraulic ram, jet pumps, etc.

Topics Covered

UNIT-I

Introduction 9

Impulse Momentum Principle, Application of momentum and momentum equation to flow through hydraulic machinery, Euler's fundamental equation, Introduction to hydro electric power plants, major components, surge tanks, etc.

Impact of Free Jets

Force exerted by the jet on stationary flat and curved, hinged plate, moving plate and moving curve vanes, effect of inclination of jet with the surface, jet propulsion of ship

Impulse Turbine

Classification of turbines, Impulse turbines, Pelton wheel, Constructional details, Working, Work done, Power and efficiency calculations, Design aspects, Governing of Impulse Turbines

UNIT-II

Reaction Turbines 9

Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitations in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines, Governing of reaction turbine

UNIT-III

Centrifugal Pumps 9

Classifications of centrifugal pumps, Construction, Working, Work done by impellor, Heads, Efficiencies of centrifugal pumps, Specific speed, Model testing, Multistage pumps, Pump in series and parallel, Performance characteristics. Net positive Section Head, Cavitations and Separation

UNIT-IV

Reciprocating Pumps: Classification, Components and Working, Single acting and double acting, Discharge, Work done and power required, Coefficient of discharge and slip, Effect of acceleration of Piston, Indicator Diagram, Air Vessels 9

Fluid system: Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, Hydraulic crane, Hydraulic lift, Hydraulic Ram, Hydraulic coupling, Hydraulic torque converter, Air lift pumps, Jet pumps

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. Impact of Jet experiment.
2. Conducting experiments and drawing the characteristics curves of Pelton wheel.
3. Conducting experiments and drawing the characteristics curves of Francis turbine.

4. Conducting experiments and drawing the characteristics curves of Kaplan turbine.
5. Conducting experiments and drawing the characteristics curves of Reciprocating pump.
6. Conducting experiments and drawing the characteristics curves of centrifugal pump.
7. Experiment on Hydraulic Jack/Press
8. Experiment on Hydraulic Brake
9. Experiment on Hydraulic Ram
10. Experiment on Compressor
11. Experiment for measurement of drag and lift on aerofoil in wind tunnel
12. Study through detailed visit of any water pumping station/plant

Books & References

1. Mechanics of Fluid – Massey B.S.(English Language Book Society, U.K.)
2. Hydraulic Machines - Jagdish Lal (S.K. Kataria & Sons)
3. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som & G. Biswas (TMH)
4. Hydraulics and Fluid Mechanics – Modi P.N, Seth S.M. (Standard Book House)
5. A Treatise on Applied Hydraulics – Addison (Chapman and Hall)

BME-52 PRINCIPLES OF MACHINE TOOLS DESIGN

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	Manufacturing Science (BME-29)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The knowledge of developments in machine tools, construction and operations of basic machine tools, tool wear and force analysis.
2. Understand the elements of mechanical and hydraulic transmission system, fundamental of kinematic structure of machine tools.
3. Demonstrate an understanding of regulation of speed, feed rates and design of machine tool structure – bed, column and housing.
4. The knowledge of designing guideways and power screw, dynamic stability of cutting process, machine tool installation and maintenance.

Topics Covered

UNIT-I 9

Introduction

Developments in machine tools, surface profiles and path produced by machine tools, features of construction and operations of basic machine tools such as lathe, drill, milling, shaper and grinding machine, General requirement of machine tool design & process, tool wear, force analysis.

UNIT-II 9

Machine Tools Drives

Classification of machine tool drives, group & individual drives, selection of electric motor, A brief review of the elements of mechanical transmission such as gear, belt, and chain drives, slider crank mechanism, cam mechanism, nut and screw transmission, devices for intermittent motion, reversing & differential mechanisms, Coupling and clutches. Elements of hydraulic transmission system- pumps, cylinder, directional valves, pressure valves etc. Fundamentals of Kinematic structure of machine tools

UNIT-III 9

Regulation of Speed and Feed rates

Laws of stepped regulation, selection of range ratio, standard progression ratio, selection of best possible structural diagram, speed chart, Design of feed box, Developing gearing diagrams. Stepless regulation of speed and feed in machine tools.

Design of Machine Tool Structure

Requirements and design criteria for machine tool structures. Selection of material's Basic design procedure for machine tool structures—bed, column & housing.

UNIT-IV 9

Design of Guideways and Power Screws

Basic guideway profiles. Designing guideways for stiffness a wear resistance & hydrostatic and antifriction guideways. Design of sliding friction power Screws. Design of spindlier & spindle supports. Layout of bearings, selection of bearings machine tools.

Dynamics of Machine Tools

General procedure for assessing the dynamic stability of cutting process, closed loop system, chatter in machine tools. Machine tool installation and maintenance

Books & References

1. Machine Tools Design & Numerical Controls –N.K. Mehta (Tata McGraw Hill)
2. Design of Machine Tools – S.K. Basu (Allied Publishers)
3. Principles of Machine Tools – A. Bhattacharya and G.C. Sen (New Central book Agency)
4. Machine Tool Design Handbook (CMTI, Bangalore)

BME-53 PRODUCTION PLANNING & CONTROL

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major

Theory Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Know about the characteristics of production systems, objective and functions of Production role of production planning in manufacturing organization, Forecasting and Market Analysis.
2. The understanding of Aggregate Planning, Routing, Scheduling and dispatching, Sheets & charts, Line Balancing.
3. Understand the concept of progress control through records and charts, inventory control, Economic lot (batch) size, Trends in purchasing and store keeping, and JIT production.
4. The Importance of productivity, productivity patterns, measurements & ratios, Human abilities, training & motivation, safety programs, workplace design

Topics Covered

UNIT-I

Introduction 9

Types and characteristics of production systems. Objective and functions of Production, Planning & Control, Role of production planning in manufacturing organization.

Preplanning

Forecasting: characteristics of demand over time, forecasting qualitative model: Delphi, naïve quantitative models: simple average, simple moving average, weighted moving average, exponential smoothing, selection of forecasting models, Market Analysis. Plant Layout, Equipment policy and replacement. Capacity planning.

UNIT-II

Production Planning 9

Aggregate Planning: Concept, strategies for aggregate planning: three pure planning strategies, graphical method for aggregate output planning, master production scheduling (MPS), and procedure for developing MPS. Routing, Scheduling and dispatching. scheduling techniques for job shop, stages in scheduling, load charts and machine loading charts, dynamic sequencing rules, scheduling product –focused systems, scheduling for flexible manufacturing system. Sheets & charts, Line Balancing.

UNIT-III

Production and Inventory Control 9

Progress control through records and charts, Types of inventories, Inventory Classification. Inventory Control under constraints, Economic lot (batch) size. Trends in purchasing and store keeping, JIT production, MRP & MRP II, comparison of Push & Pull systems, ERP, CAPPC.

UNIT-IV

Productivity 9

Importance, Productivity patterns, productivity measurements & ratios, improvement majors.

Human Factors & Ergonomics
Human abilities, training & motivation, safety programs, workplace design.

Books & References

1. Elements of Production Planning & Control –Eilon (Universal Publishing Corporation)
2. Production Planning Control and Industrial Management – Jain and Agrarwal (Khanna Publishers)
3. Modern Production Operations Management – Buffa (John Wiley & Sons Inc)
4. Manufacturing Planning and Control Systems - Vollmann Thomas E, Bery William L (McGraw-Hill)
5. Production Systems – J.L. Riggs (John Wiley and Sons)

BME-54 INDUSTRIAL TRIBOLOGY

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the scope of tribology and its applications in manufacturing and machining processes.
2. The knowledge of theory of friction and its mechanisms in metals, ceramics and polymers.
3. The knowledge of wear, its classification, different theories, wear models and its engineering applications.
4. The understanding of lubrication, types of lubricant and their flow, and different lubrication mechanisms.

Topics Covered
UNIT-I
Introduction 9
Definition and Scope of tribology, Contact of solids, Surface topology, Surface interaction.
Applications
Application of tribology in manufacturing processes, Metal machining, Metal cutting, Tool wear,

Action of lubricants, Friction welding, Extrusion process

UNIT-II

Friction 9

Definitions, Types, Friction laws, Modern theory of dry solid friction, Mechanism of rolling friction, measurement of friction, friction of metals ceramics and Polymers

UNIT-III

Wear 9

Classifications, wear models, factors affecting wear, Theories of adhesives, Abrasives, Surface fatigue and corrosive wear, Miscellaneous wear theory such as Erosive, cavitations and Fretting wear, Wear of miscellaneous machine components such as gears, Plane bearings and rolling elements.

UNIT-IV

Lubrication 9

Lubrication of bearing, Lubricant, Mineral Oil, Grease, Solid lubricant, Lubrication regime, Viscous flow, Reynolds equation and its limitations, Hydrodynamic lubrication, Hydrostatic lubrication, Elastohydrodynamic lubrication, Boundary lubrication, Squeeze films.

Books & References

1. Engineering Tribology – P Sahoo (Prentice Hall of India)
2. Principles and Applications of Tribology - D.F. Moore (Pergamon Press)
3. Fundamentals of Tribology - Basu, Sengupta & Ahuja (Prentice Hall of India)
4. Friction and Wear of Engineering Materials- I.M. Hutchings (Edwar Arnold, London)
5. Friction and Lubrication- E.P. Bowden and Tabor (Oxford Clarendon Press)
6. Engineering Tribology- Stachowiak & Batchelor (Butterworth-Heinemann)

BME-55 TOTAL QUALITY MANAGEMENT

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The understanding of quality concepts, total quality management, development of sources, quality in sales and services, analysis of claims.
2. The knowledge of Organization structure and design, quality function deployment, quality cost, Attitude of top management, operator's attitude and responsibility.

3. The understanding of mathematics of control charts, construction and analysis of $\bar{X}$, R, p and C- charts and use of control charts.
4. The knowledge of Defects diagnosis and prevention, correcting measure, reliability control, maintainability, zero defects, quality circle, ISO-9000, Taguchi method and JIT in some details.

Topics Covered

UNIT-I

Quality Concepts 9

Evolution of Quality control & concept, TQM concept, Quality concept in design, Review of design, Evolution of prototype.

Control on Purchased Product

Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

Manufacturing Quality

Methods and Techniques for Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims.

UNIT-II

Quality Management 9

Organization structure and design, Quality function deployment, Economics of quality value and contribution, Quality cost: Prevention, appraisal, internal failure & external failure costs, optimizing quality & cost reduction programme, use of QM initiatives, tools, and techniques in an organization.

Human factor in quality

Attitude of top management, co-operation of groups, operator's attitude & responsibility—causes of operator's error and corrective methods.

UNIT-III

Control charts 9

Theory of control charts, construction and use of $\bar{X}$ & R charts, process capability study, use of control charts, Limitations of X bar and R charts.

Attribute control charts

Defects, construction and analysis of using p-chart, effect of variable sample size, construction and use of C-chart.

UNIT-IV

Defects Diagnosis and Prevention 9

Defect study, identification and analysis of defects, corrective measures, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

IS0-9000 and its concept of Quality Management

Introduction, characteristics of quality assurance system. ISO -9000: scope, application, terms & definitions, evolution of ISO-9000 series, ISO 14000 Taguchi method, JIT

Books & References

1. TQM in New Product Manufacturing - Menon, H.G. (McGraw Hill)
2. Total Quality Management - Lt. Gen. H. LaI (Wiley Eastern Limited)
3. Beyond Total Quality Management - Greg Bounds (McGraw Hill)
4. The Management & Control of Quality - Evans & Lindsay (Thompson South-Western).
5. Total Quality Management: Text & Cases - Jankiraman & Gopal (PHI Learning New Delhi).
6. Total Quality Management: A Primer - S M Sundara Raju (Tata McGraw Hill, New Delhi).
7. Introduction to Quality Management and Engineering - Sower, Savoie & Renick (Pearson Education Asia).
8. Total Quality Management - Besterfield Dale H (Pearson Education Asia, Second Edition).
9. Total Quality Management: A Practical Approach - H Lal (New Age International)

BME-56 ENERGY MANAGEMENT

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The importance and applications of renewable energy sources their utilization and energy management.
2. Students will be able to apply the 1st and 2nd law of thermodynamics for energy audit performance analysis of different solar systems.
3. The student will be able to convert the electrical energy for comfort of human being in a building and energy audit of combustion process.
4. Student will be able to understand the effect of pollution in environment and government's regulation to control them.

Topics Covered

UNIT-I 9

Introduction to energy, Sources of energy, Forms of energy, Energy reserves, renewable energy sources, Unites of energy and the laws of thermodynamics. Definition & objective of energy management, importance, Indian need of energy management, duty and responsibility of energy management. Energy consumption and GDP, energy database, Energy demand analysis, Costs of exploration and utilization of depletable resources, energy pricing, National energy plan.

UNIT-II 9

Energy audit concepts, Energy audit based on 1st law and 2nd law of thermodynamics, Mass and Energy balances, Availability analysis, Evaluation of energy conserving Opportunities, Economic analysis and life cycle costing. Energy conservation areas, Energy transmission and storage, Plant wide energy optimization Models, Data base for energy management

UNIT-III 9

Energy conservation through controls, Computer aided energy management, Program organization and methodology. Electrical energy conservation in building lighting, heating, ventilating and air conditioning, Energy efficient motor, power factor improvement in power systems, Energy audit of Combustion process, Boilers, Turbines, compressors, Pumps, Heat exchangers, Condensers, Use of industrial, wastes.

UNIT-IV 9

Energy environment interaction, Environmental issues, Global warning, Carbon dioxide emissions, Depletion of ozone layer, Government's regulations, and Energy economy interaction. Organizing the management: location of energy management, top management support, managerial function, accountability, motivation of employees, marketing and communication, training and planning

Books & References

1. Energy Management and Convention - Clive Beggs, Butterwoth Heinemann (Elsevier Science)
2. Optimising Energy Efficiency in the Industry – Rajan (Tata McGraw Hill)
3. Guide to Energy Management - C.L Capehart (Fairmont Press)
4. Renewable Energy Sources and their Environment Impact - Abbasi & Abbasi (Prentice Hall of India)
5. Environmental Risks and Hazards – Cutter (Prentice Hall of India)
6. Energy and Power Risk Management: New Developments in Modeling, Pricing and Hedging - Alexander Eydeland (John Wiley & Sons)
7. Energy Management Handbook - Wayne C. Turner (John Wiley & Sons Inc).
8. Thermodynamics - Kenneth Wark (Tata McGraw Hill)
9. Exergy Analysis of Thermal, Chemical and Metallurgical Process - Jan Szargut, David R. Morris, Frank R. Steward, Hemisphere Pub (Springer Verlag Publisher)

BME-57 MECHANICAL VIBRATIONS

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand different types of vibration and mathematical analysis of single degree freedom system under free vibration and damped vibration.
2. The mathematical analysis of single degree freedom system subjected to forced vibration; understand the principles and working of vibration measuring instruments and able to calculate the critical speeds of shaft.
3. Understand the analysis of two degree freedom system under free, damped and forced vibrations and principle and working of different types of vibration absorbers.
4. The ability to carry out exact and numerical analysis of multi degree freedom system subjected to different types of vibration.

Topics Covered

UNIT-I

Introduction 9

Periodic motion, Harmonic motion, Superposition of simple harmonic motions, Beats, Fourier analysis

Single Degree Freedom System: Free Vibration

Free vibration-spring mass system, torsional system, Natural frequency, Equivalent systems, Energy method for determining natural frequency, Response to an initial disturbance, Phase plane method

Single Degree Freedom System: Damped Vibration

Damping models, Vibrations of spring-mass system with viscous damping, Logarithmic decrement

UNIT-II

Single Degree Freedom System: Forced Vibration 9

Forced vibration, Harmonic excitation with viscous damping, steady state vibrations, Forced vibrations with rotating and reciprocating unbalance, Support excitation, Vibration isolation, Force Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments

Critical Speed of Shaft

Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed

UNIT-III

Two Degree Freedom systems 9

Introduction, Free vibration-spring-mass system, principal modes, double pendulum, torsional system, Coupled rectilinear and angular modes, Damped Vibration-spring-mass system, Force vibration-spring mass system with harmonic excitation

Vibration absorbers

Introduction, Undamped dynamic vibration absorber, Torsional absorber, Centrifugal pendulum absorber, Dry friction damper

UNIT-IV

Multi Degree Freedom system: Exact Analysis 9

Undamped free and forced vibrations of multi-degree freedom systems, influence number, Maxwell's reciprocal theorem, Torsional vibration of multi-degree rotor system, Principal

coordinates, Continuous systems- longitudinal vibrations of bars, torsional vibrations of circular shafts

Multi Degree Freedom system: Numerical Analysis

Rayleigh's, Dunkerely's, Holzer's and Stodola methods

Books & References

1. Elements of Vibration Analysis– L. Meirovitch (McGraw-Hill Company)
2. Mechanical Vibrations – P. Srinivasan (Tata McGraw Hill)
3. Mechanical Vibrations – G. K. Grover (Jain Brothers, Roorkee)
4. Mechanical Vibrations – W. T. Thomson (George Allen & Unwin)
5. Theory and Practice of Mechanical Vibrations – J S Rao & K Gupta (New Age International)
6. Mechanical Vibrations – Tse, Morse & Hinkle (CBS Publishers & Distributors Pvt. Ltd)
7. Mechanical Vibrations – V. Rama Murthy (Narosa Publications)
8. Mechanical Vibrations- V. P. Singh (Dhanpat Rai & Co.)

BME-58 RENEWABLE ENERGY TECHNOLOGIES

Course category	:	Programme Electives (PE1 & PE2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The importance and applications of renewable energy sources their utilization and collection of solar energy.
2. Student will be able to understand the application of solar energy and wind energy, its conversion, performance analysis of different solar collectors and solar photovoltaic system.
3. The understanding of photosynthesis, bio gas production aerobic and anaerobic bio conversion process, bio gas applications and energy recovery from urban waste and bio mass resource development in India.
4. The knowledge of the fundamentals and application of tidal power, ocean thermal energy, wave energy, geo thermal energy and hydro energy.

Topics Covered

UNIT-I

Energy resources 9

Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation.

Solar Energy

Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Collection of Solar Energy

Solar thermal power and it's conversion, Solar collectors, Flat plate, Performance analysis of flat plate collector, Solar concentrating collectors, Types of concentrating collectors, Thermodynamic limits to concentration, Cylindrical collectors, Thermal analysis of solar collectors, Tracking CPC and solar swing .

UNIT-II

Solar Energy Applications 9

Application of solar energy- Solar water and air heaters, distillation, drying of materials, power generation, cookers, solar refrigeration. Photo voltaic technology.

Wind Energy

Properties of wind, Availability of wind energy in India, wind velocity, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Wind energy farms, Economic issues, Recent development.

UNIT-III

Bio-mass Energy 9

Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc., Applications of Gasifiers to thermal power and Engines, Biomass as a decentralized power generation source for villages.

Fuel Cell

Fuel cell – Principle of working, construction and applications

UNIT-IV

Geothermal Energy 9

Geological setting, different geothermal systems, utilization of geothermal energy, its economical and environmental comparison.

Brief description of different utilization techniques for ocean thermal energy, and tidal and wave energy.

Hydel Energy

Hydro power: Potential, Hydropower Generation and Distribution, Mini and Micro-hydel Power (MHP) Generation: Classification of hydel plants, Concept of micro hydel, merits, MHP plants: Components, design and layout, Turbines, efficiency, Status in India.

Books & References

1. Renewable Energy Sources and Conversion Technology - Bansal Keemann, Meliss (Tata

McGraw Hill)
2. Renewable Energy Resources and Emerging Technologies - Kothari D.P. (Prentice Hall of India)
3. Nonconventional Energy - Ashok V. Desai (New Age International Publishers Ltd.)

BME-61 POWER PLANT TECHNOLOGIES

Course category	:	Programme Electives (PE3 & PE4)
Pre-requisite Subject	:	Engineering Thermodynamics (BME-12)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the magnitudes of conventional and renewable energy resources and economics of power plants.
2. Able to understand steam power plant with its components.
3. Able to understand diesel engine power plant and gas turbine power plant with their components.
4. Able to understand nuclear power plant and hydro-electric power plant with their components.

Topics Covered

UNIT-I

Introduction Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. 9

Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant units

Power plant economics and selection Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection

UNIT-II

Steam power plant General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating , flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and 9

efficiency, Site selection of a steam power plant.

UNIT-III

Diesel power plant General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant. 9

Gas turbine power plant Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant

UNIT-IV

Nuclear power plant Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. 9

Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems.

Books & References

1. Power Plant Engineering - F.T. Morse (Affiliated East-West Press Pvt. Ltd)
2. Power Plant Technology – El Vakil (McGraw Hill)
3. Power Plant Engineering - P.K. Nag (Tata McGraw Hill)
4. Steam & Gas Turbines & Power Plant Engineering - R. Yadav (Central Pub House)

BME-62 TURBO MACHINERY

Course category	:	Programme Electives (PE3 & PE4)
Pre-requisite Subject	:	Engineering Thermodynamics (BME-12)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Student will be able to understand the working and construction of impulse steam turbine, velocity triangles and designing of blades.
2. Student will be able to understand the working and construction of reaction steam turbine, velocity triangles, degree of reaction and various losses.
3. Student will be able to understand the working and construction of centrifugal and axial flow compressor and their velocity triangles and performance calculations.

4. Students will be able to demonstrate the working of gas turbine plants and efficiency calculations. Further mechanical design consideration followed by turbine blade cooling.

Topics Covered

UNIT-I

Impulse Turbines 9

Steam turbine– Principal of operation of steam turbine, Types, Impulse turbine compounding of steam turbine- pressure compounded velocity compounded and pressure – velocity compounded impulse turbine, Velocity diagram for impulse turbine, Force on the blade and work done, Blade or diagram efficiency, Gross stage efficiency. Influence of ratio of blade to steam speed on blade efficiency in a single stage impulse turbine. Efficiency of multi-stage turbine, Impulse blade sections, Choice of blade angle. Blade height in velocity compounded impulse turbine. State Point Locus and Reheat Factor**,** Governing of steam turbine

UNIT-II

Impulse Reaction Turbines 9

Velocity diagram, Degree of reaction, Impulse-reaction turbine with similar blade section and half degree of reaction (Parson's turbine), Height of reaction Turbine blade section, Internal losses in steam turbine Nozzle, Losses, Blade friction losses, Disc friction losses, Blade windage losses or partial admission losses, Gland leakage or clearance losses, Leaving velocity or residual loss, Carry loss.

UNIT-III

Centrifugal compressors 9

Introduction, Classifications of Centrifugal compressors – components, Working, Work done, Velocity Diagrams, Calculations of power and efficiencies, Slip factor, Surging and choking power and Efficiencies, Stage pressure rise, Loading coefficient, Diffuser, degree of reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.

Axial flow compressor- Construction, Principle of operation and working, Energy transfer, Velocity Diagram, Factors affecting Stage Pressure Rise, Blockage in Compressor Annulus, Degree of reaction, 3-D flow, Design Process, Blade Design, Calculation of Stage Performance, Axial flow Compressor Characteristic Curves.

UNIT-IV

Gas Turbine: Classification of gas turbine, Simple open cycle gas turbine, Ideal and actual cycle (Brayton Cycle) for gas turbine, Optimum pressure ratio for maximum specific output in actual gas turbine, Regeneration, Reheat and inter cooling and effect of these modification on efficiency and output, Closed cycle gas turbine. 9

Turbine Blade cooling: Different cooling techniques, Types of coolants, Comparative evaluation of different cooling techniques.

Mechanical Design consideration: Overall design choices, Material selection, Design with traditional materials.

Books & References

1. Steam and Gas turbine – By R. Yadav (Central Publishing House)
2. Gas Turbine – V. Ganeshan (TMH)

3. Thermal Turbomachines – Onkar Singh (Wiley India Pvt. Ltd.)
4. Turbine Compressors and Fans – S.M. Yahya (TMH)
5. Turbines, Compressors and fans - S.M. Yahya (Tata McGraw-Hill)
6. Gas turbine theory - Cohen & Rogers, Addison Weslay (Longman Ltd.)
7. Design of high efficiency turbomachinery and gas turbines - David Gordon (Wilson)

BME-63 PROJECT MANAGEMENT

Course category : Programme Electives (PE3 & PE4)
Pre-requisite Subject : NIL
Contact hours/week : Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits : 4
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Knowledge of various phases of project management.
2. Knowledge of structure of different types of organization and its selection.
3. Know about project appraisal and cost estimation.
4. Understand the various aspects of CPM and PERT and their implementation in Project.

Topics Covered

UNIT-I 9

Project Management Concepts: Introduction, project characteristics, taxonomy of projects, project identification and formulation. Establishing the project and goals, Nature & context of project management; phases of PM, A framework for PM issues, PM as a conversion process, project environment & complexity, Organizing human resources, organizing systems & procedures for implementation

UNIT-II 9

Project Organization & Project Contracts: Introduction, functional organization, project organization, matrix organization, modified matrix organization, pure project organization, selection of project organization structure, project breakdown structures, project contracts, types of contracts, types of payments to contractors.

UNIT-III 9

Project Appraisal & Cost Estimation: Introduction, technical appraisal, commercial appraisal, economic appraisal, financial appraisal, management appraisal, social cost/benefit analysis, project risk analysis, Cost analysis of the project, components of capital cost of a project, modern approach to project performance analysis.

UNIT-IV 9

Project Planning & Scheduling: Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, slacks & floats, PERT model, , PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique, Complexity of project scheduling with limited resources.

Books & References

1. Project Management - K. Nagarajan (New Age International)
2. Operation Research for Executive – L. S. Srinath (EWP)
3. Guide to the Project Management Body of Knowledge - Project Management Institute (Project Management Inst)
4. Project Management - Greer Michael (Jaico Publications)
5. Successful Project Management - Trevor Young (Kogan page)

BME-64 ADVANCED WELDING TECHNOLOGY

Course category	:	Programme Electives (PE3 & PE4)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the importance and application of welding, conventional welding, weld design and inspection/testing.
2. Develop good knowledge about Thermal and Metallurgical consideration of welding, HAZ, automation and safety in welding.
3. Student will have through knowledge about plasma arc, laser beam, electron beam, ultrasonic and diffusion welding.
4. Develop good knowledge about explosive welding, underwater welding, metal spraying and surfacing.

Topics Covered

UNIT-I 9

Introduction

Importance and application of welding, problems and drawbacks associated with conventional welding processes, Selection of welding process, Brief review of conventional welding process

Weld Design

Welding machines/equipments and its characteristics, Heat input and heat flow, Weld defects and distortion, Inspection/testing of welds, Life prediction

UNIT-II 9

Thermal and Metallurgical considerations

Thermal considerations for welding, temperature distribution, Analytical/Empirical analysis/formulae, heating & cooling, curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification of weld and properties

Automation in welding, Economics of Welding, Safety in welding

UNIT-III 9

Advanced welding Techniques-1

Principle, equipment, working and applications of Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding and Diffusion welding

UNIT-IV 9

Advanced welding Techniques-2

Principle, equipments, working and applications of explosive welding/ cladding, underwater welding, metal spraying and surfacing.

Books & References

1. Welding Processes and Technology – Dr. R. S. Parmar (Khanna Publication)
2. Manufacturing technology – Foundry, Forming and Welding- P. N. Rao (Tata McGraw Hill).
3. Welding and Welding Technology – Richard L. Little (Tata McGraw Hill).
4. Workshop Technology Vol1-B. S. Raghuvanshi (Dhanpat Rai and Sons)

BME-65 ADVANCED MANUFACTURING TECHNOLOGY

Course category	:	Programme Electives (PE3 & PE4)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the need of unconventional manufacturing processes and familiar with abrasive water jet cutting and machining process.
2. Knowledge of working principle, advantages, limitations and applications of Electro-chemical Machining, Electric Discharge machine and chemical machining.
3. Understand working, effect of process variables and applications of Laser beam

machining, Electron beam machining, Ultrasonic machining, Plasma arc machining.

4. Knowledge High energy forming processes, and Diffusion and Photo- Lithography process.

Topics Covered

UNIT-I 9

Introduction

Limitations of conventional manufacturing processes, need of unconventional manufacturing processes & its classification and its future possibilities.

Water Jet Cutting (WJC): WJC machine, Process characteristics and application.

Abrasive Jet machining: Machining setup, parametric analysis and applications.

Abrasive Water Jet machining: Working principle, process variables, Cutting parameters and process capabilities.

UNIT-II 9

Advanced Machining Processes-1

Working principle, machine/equipment, process variables, advantages, limitations and applications of Electro-Discharge machining (EDM), Electrochemical machining (ECM), Chemical machining (CM), Electro chemical grinding and Electro discharge grinding.

UNIT-III 9

Advanced Machining Processes-2

Working principle, machine/equipment, process variables, advantages, limitations and applications of Laser beam machining (LBM), Electron beam machining (EBM), Ultrasonic machining (USM), Plasma arc machining (PAM)

UNIT-IV

Unconventional Forming processes 9

Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electrodischarge forming, water hammer forming, explosive compaction etc.

Electronic-device Manufacturing

Brief description of Diffusion and Photo- Lithography process for electronic-device manufacturing

Books & References

1. Advanced Machining Processes– Vijay K. Jain (Allied Publishers Pvt Ltd.)
2. Modern Machining Process- Pandey and Shan (Tata McGraw Hill).
3. Non-Conventional Machining – P.K. Mishra (Narosa Publishing House).
4. Non Traditional Manufacturing Process – Gary F. Benedict (Marcel Dekker)
5. Machining Process :Conventional and Non-Conventional Process-Hassan Abdel-Gawad El-Holy (CRC Press –Taylor and Francis)

BME-66 ADVANCED ENGINEERING MATERIALS

Course category : Programme Electives (PE3 & PE4)

Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To understand the basic structures, atomic bonding, and importance of materials for different applications.
2. To understand the surface behavior of materials with their phase diagrams.
3. The knowledge of ferrous and nonferrous materials with the inclusion of advanced materials.
4. The knowledge and applications of Mechanical and thermal behavior of different materials.

Topics Covered

UNIT-I

Introduction 9

Brief history of engineering materials, Importance of materials, Classification of Materials, Engineering Materials, Advanced Materials and Future Materials

Crystallography

Atomic Structure, Atomic Bonding in Solids, Bravais Lattices, Crystal Structures, Crystalline, Quasi Crystalline and Non-Crystalline Materials, Miller Indices, Miller-Bravais Indices for Planes and Directions of Cubic and Non-Cubic Structures.

UNIT-II

Structural Analysis of Materials 9

Microstructural phenomenon for different materials, Diffusion Mechanisms, Fick's Laws, Steady & Non-steady State Diffusion, Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM).

Phase Diagrams

Phase Rule, Equilibrium Phase Diagrams, Phase Systems. Iron-Carbon Phase Diagram, TTT Diagram Imperfections in Solids, Recovery, Recrystallization and Grain Growth, Mechanisms of Strengthening, Solid Solution Strengthening.

UNIT-III

Ferrous &Non ferrous alloys 9

Ferrous Alloys: Low Alloy and High Alloy Steels, Tool Steels, Stainless Steels, Cast irons etc.
Non-ferrous alloys: Copper and its alloys, Aluminum and its alloys, Nickel, Zinc, Shape Memory Phenomenon and Alloys; Ceramics, Cermets, Glass and Carbon Products; Failure Prevention; and The Selection Process.

Advanced Materials

Composite materials, Nano materials, Smart materials, Optical materials etc.

UNIT-IV

Mechanical Behavior of Materials 9

Study about Stress strain diagram for brittle & Ductile materials (Mild steel), elastic constants, work hardening ,Hot and cold working, Fracture, Ductile and Brittle Fracture, Griffith's theory of brittle fracture, Ductile-Brittle Transition, Stress Intensity Factor (SIF), Hardness, Impact Testing, Bending, Fatigue, Creep etc.

Thermo-Mechanical Behavior of Materials

Thermo-gravimetric analysis (TGA), Dynamic mechanical analysis (DMA), Thermal conductivity etc.

Books & References

1. A Materials and processing approach - G.E. Dieter (McGraw Hill)
2. Materials selection in Mechanical Design- M.F Ashby (Pergamon press)
3. Engineering Materials Properties and Selection - Kenneth G. Budinski (Prentice Hall of India)
4. Engineering Metallurgy Part 1- R.A. Higgins (Edward Arnold)
5. Selection of Engineering Materials- Gladius Lewis (Prentice-Hall)

BME-67 ADVANCED MECHANICS OF SOLIDS

Course category	:	Programme Electives (PE3 & PE4)
Pre-requisite Subject	:	Mechanics of Solids (BME-14)
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding and application of three dimensional stress and strain, principal stresses and principal strains, Mohr circle.
2. Understanding of generalized Hooke's law, relation between elastic constants, equations of equilibrium and determination of stresses & deflection due to unsymmetrical bending.
3. Determine stresses due to rotation of uniform and variable thicknesses of solid disc, rotating shafts and cylinders. Design of thick cylindrical shell and compound cylinders subjected to internal and external pressure.
4. Determine stresses in curved beams such as crane hooks and circular ring under tension and compression. Torsional stresses of prismatic, circular, elliptical bars and thin walled tubes & rolled section.

Topics Covered

UNIT-I

Analysis of Stress and Strain 9

Stress at a point and state of stress, Stress and Strain tensor, Principal stresses and principal planes, Stress invariants, Mohr's stress circle for 3D state of stress, Planes of maximum shear, Octahedral stresses, State of pure shear, Plane state of stress, Differential equations of equilibrium

Analysis of strain

Introduction, Deformations, Deformation in the neighborhood of a point, State of strain at a point, Shear strain components, Cubical dilatation, Principal axes of strain and principal strains, Plane state of strain, Compatibility conditions.

UNIT-II

Stress Strain relations for Linearly Elastic Solids 9

Generalized statement of Hooke's law, Stress-strain relationships for isotropic materials, Modulus of rigidity, Bulk Modulus, Young's modulus and Poisson's ratio, Relation between the elastic constants, Displacement equations of equilibrium, Thermoelastic stress-strain relations

Unsymmetrical bending and Shear centre

Stresses due to unsymmetrical bending, Deflection of beams due to unsymmetrical bending, Determination of shear centre and flexural axis for I-section and channel section

UNIT-III

Stresses in Axi-symmetric Bodies due to Rotation 9

Stresses due to rotation of solid discs of uniform thickness and disc with a hole, Disc of variable thickness, Rotating shafts and cylinders

Thick cylindrical shell

Stresses in thick cylinders subjected to internal or external pressures, Design of thick cylindrical shell, Compound cylinders, Stresses due to interference fits

UNIT-IV

Curved Beams 9

Bending of beams with large initial curvature, Position of neutral axis for rectangular, circular, triangular and trapezoidal cross-sections, Stresses in crane hooks and circular rings under tension and compression

Torsion of Non Circular Bars

Torsion of Prismatic, circular and elliptical bars, Torsion of rectangular bars, Torsion of thin walled tubes, Torsion of rolled sections

Books & References

1. Advanced Mechanics of Materials - P. Boresi (Wiley)
2. Mechanics of Materials – Popov (Pearson US Imports & PHIPEs)
3. Advanced Mechanics of Solids-L S Srinath (Tata McGraw Hill)
4. Mechanics of materials-Pytel (CL Engineering)
5. Strength of Materials-Ryder (Mcmillan Publishers India Limited)
6. Strength of Materials-Timoshenko and Young (Tata McGraw Hill)
7. Strength of Materials-S. Ramamurtham (Dhanpat Rai Publishing Co.)
8. Strength of Materials-R. K. Rajput (S. Chand)
9. Strength of Materials–R. K. Bansal (Lakshmi Publications)

BME-68 GAS DYNAMICS AND PROPULSION

Course category	:	Programme Electives (PE3 & PE4)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Student will understand the concept of gas dynamics, fundamental equations and isentropic flow.
2. Ability to get the knowledge of compressible flows and pertaining calculations.
3. Student will be able to demonstrate the wave phenomena and make calculations for variable flow area like nozzle design pressure and efficiency.
4. Able to understand and demonstrate the basics of jet propulsion, various jet propulsion engines and their efficiency calculations.

Topics Covered

UNIT-I

Concept of Gas Dynamics 9

Introduction, Applications

Fundamental Equations of Steady Flow

Introduction, Assumption, Equation of Continuity, Control Volume, Momentum Equation, Bernoulli's Equation, Steady Flow Energy Equation.

Isentropic Flow

Introduction, Acoustic Velocity, Flow from a Reservoir, Flow Parameters

UNIT-II

Diabetic Flow 9

Introduction, Stagnation Temperature, Rayleigh Line, Pressure Ratio, Temperature Ratio.

Flow with Frication and No Heat Transfer Adiabatic Flow

Introduction, Frication Loss, The Fanning Equation, Frication Factor, Fannoline.

UNIT-III

Wave Phenomena 9

Introduction, Normal Shock Waves, Oblique Shocks.

Variable Area Flow

Introduction, Velocity, Criteria for Acceleration and Deceleration, Effect of Back Pressure on Nozzle Flow, Over-expanding and Under-expanding Nozzles, Design Pressure, Nozzle Efficiency.

UNIT-IV

Jet Propulsion 9

Introduction, Types, Pulse jet, Ram jet, Turbo-jet, Efficiency and Horse Power of Propulsion, Flying Unit.

Books & References

1. The Dynamics and Thermodynamics of Compressible Fluid Flow, Vol. I – Shapiro (Ronald Press Co.)
2. Gas Dynamics - Cambel and Jennings (McGraw Hill)
3. Elements of Gas Dynamics – Mattingly (Tata McGraw-Hill Education)
4. Fundamental of gas dynamics – Zucker, and Biblarz (John Wiley & Sons, Inc)
5. Dynamics of compressible flow- Yahya (New Age Publishers, Delhi)