UG

Welding Technology

SYLLABUS

2016-Scheme

Vision of the department

The department shall strive to act as a podium for the development and transfer of technical competence in academics, impart appropriate skills, entrepreneurship and research in the field of Mechanical Engineering to meet the changing need of society.

Mission of the department

1. To provide modular programmes from skill development to the research level.
2. To impart technical education and training in innovative state-of-the-art technology in the field of mechanical engineering.
3. To disseminate of knowledge and information by organizing seminars/ workshops/short term courses in a planned manner.
4. To provide extension services to rural society, industry professionals, institutions of research and higher learning in the field of mechanical engineering.
5. To interact with the industry, educational and research organizations, and alumni in the fields of curriculum development, training and research for sustainable social development and changing needs of society.

Programme Outcome (PO) s: UG

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and manufacturing/welding specialisation for the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex mechanical/welding engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex mechanical engineering problems or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems:** Conduct investigations of complex manufacturing/welding problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** To apply appropriate techniques, resources and engineering and IT tools for modelling of different manufacturing/welding problems with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the manufacturing/welding engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex manufacturing/welding engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of manufacturing/welding engineering and management principles and apply these to

one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Participate and succeed in competitive examination for higher studies.

Program specific outcomes (PSO)

1. Graduates having an ability to identify, analyze and solve engineering problems relating to mechanical systems together with allied engineering streams.
2. Graduates will be able to build the nation, by imparting technological inputs and managerial skills to become Technocrats and Entrepreneurs.
3. Graduates will be able to develop new concepts on various emerging fields and pursue advanced research.

Title of the course : **Higher Engineering Mathematics**
Subject Code : **AMT–511**

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about the basic concepts of Mathematics.

CO2: Understand various rules of Mathematics and how it is applied on solve different equations.

CO3: Understand the behavior of differential equations and integration.

CO4: Learn about the mechanism different formulas derivations and theorem.

CO5: Get knowledge about complex matrix, transformations, theorem and their properties.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
CO1	3	1	3	2	2	2	2	3	2	2	2	2	-	-	-
CO2	3	1	3	1	1	3	3	3	3	2	3	3	1	-	1
CO3	3	3	3	3	1	2	1	1	3	2	3	2	-	-	-
CO4	3	1	3	1	3	2	2	2	2	2	2	2	1	2	1
CO5	3	3	3	3	1	3	1	1	3	2	2	3	-	1	1
Avera	3	1.8	3	2	1.6	2.4	1.8	2	2.6	2	2.4	2.4	1	1.5	1

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	1. Laplace transforms	Laplace transforms of elementary functions. Properties of Laplace transform. Transform of derivatives and integrals. Evaluation of integrals by Laplace transforms. Inverse Laplace transforms. Convolution theorem. Solution of ordinary differential equations. Unit step function and unit impulse function. Engineering applications.	7
	2. Fourier series	Fourier series. Change of interval. Even and odd functions. Half-range series.	5
	3. Partial derivatives and expansions	Functions of two or more variables. Partial derivatives. Homogenous functions. Euler's Theorem. Total derivative. Derivative of an implicit function. Tangent and normal to a	9

		surface. Change of variables. Jacobians. Taylor's and Maclaurin's series expansions for a function of two variables.	
Unit-2	4. Complex functions	Limit of a complex function. Differentiation. Analyticity. Cauchy-Riemann equations. Harmonic functions. Conformal mapping. Some special transformations- translation, inversion and rotation. Bilinear transformation.	7
	5. Multiple integral	Double integral. Change of order of integration. Triple integral. Change of variables. Applications to area and volume. Beta and Gamma functions.	8
	6. Vector Calculus	Differentiation of a variable vector. Scalar and vector point functions. Vector operator - Del. Gradient, curl and divergence - their physical interpretation and applications. Directional derivative. Line, surface and volume integrals. Theorems of Green (in plane), Gauss and Stoke (without proof) - their verification and applications.	9

Total=45

Recommended Books:

1. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishers.
2. G.B. Thomas & R.L. Finney, Calculus: Analytical Geometry, Addison Wesley.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern.
4. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill.

Subject Code : MET-511
Title of the course : ENGINEERING MECHANICS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the basic laws of Engineering Mechanics
CO2: Calculate and analyze the various forces acting on engineering component
CO3: Solve complex Engineering problems by applying mechanics laws
CO4: Analyze various forces acting on elements of truss
CO5: Understand and analyze the kinetics of particle

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	3	2	3	2	2	2	3	2	3	2	2	2	1	-
CO2	2	3	3	2	3	3	3	2	3	2	3	3	1	-	1
CO3	2	2	3	3	2	2	2	3	2	3	2	2	1	2	2
CO4	2	3	3	3	3	3	2	3	3	2	3	2	2	1	-
CO5	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
Average	2.4	2.6	2.8	2.6	2.6	2.4	2.2	2.6	2.6	2.4	2.4	2.2	1.4	1.5	1.333 33

Theory

Course Description	Lecture(s)
Unit-I	
Fundamentals of Mechanics	
Fundamental concept of mechanics and applied mechanics, idealization of mechanics, Basic dimensions and units of measurements, concept of rigid bodies, Laws of Mechanics	**04**
Laws for Forces	
Control Scalars and Vectors, Vector operations, Vector addition of forces, Force and its effects, characteristics of force vector, Bow's notation Force systems: Coplanar and space force systems. Coplanar concurrent and non-concurrent forces. Free body diagrams,	**04**
Resultant and components of forces	
concept of equilibrium; parallelogram law of forces, equilibrium of two forces; super position and transmissibility of forces, Newton's third law, triangle law of forces, different cases of concurrent, coplanar two forces systems, extension of parallelogram law and triangle law to many forces acting	**04**

at one point	
Polygon law of forces	
Triangle law to many forces acting at one point - polygon law of forces, method of resolution into orthogonal components for finding the resultant, graphical methods, special case of three concurrent, coplanar forces, Lami's theorem	**04**
Moments & Couples	
Concept of moment, Varignon's theorem, Principle of moments, Moment of forces about a specified axis, concept of couple - properties and effect, Moment of couple, Movement of force on rigid body, Resultant of force and couple system, Reduction of force and couple system, Parallel forces - like and unlike parallel forces, calculation of their resultant	**03**
Trusses	
Simple trusses, analysis of simple truss, Method of Joints, Method of sections	**05**
UNIT II	
Friction	
Concept of friction, Characteristics of Dry friction, Laws of Coulomb friction, limiting friction, coefficient of friction; sliding friction and rolling friction, Belt friction, Ladder friction.	**05**
Centre of Gravity	
Concept of gravity, gravitational force, centroid and centre of gravity, centroid for regular lamina and centre of gravity for regular solids. Position of centre of gravity of compound bodies and centroid of composite area. CG of bodies with portions removed.	**06**
Simple Lifting Machines	
Concept of machine, mechanical advantage, velocity ratio and efficiency of a machine, their relationship, law of machine, Simple machines : lever, wheel and axle, differential wheel & axle, pulley systems, simple screw jacks, winch crab (single & double	**06**
Kinetics of particle	
Types of motion, linear motion with uniform velocity, uniform & varying acceleration, motion under gravity, motion of projectiles, relative motion of a particle. Newton's laws of motion, equation of motion, equation of motion for system of particles, D' Alembet's Principle, Motion of connecting bodies. Concept of momentum, Impulse momentum principle, Conservation of momentum, Principle of work and energy.	**07**

Total=48

Recommended Books:

1. J. L. Mariam & L. G. Kraige , Engineering Mechanics. John Wiley & Sons
2. R. C. Hibbeler, Engineering Mechanics (Static & Dynamics), Prentice Hall
3. Beer & Johnston, Engineering Mechanics (Static & Dynamics), McGraw Hill
4. Boresi&Schimidt, Engineering Mechanics (Static & Dynamics), Cengage Learning
5. R. K. Rajput, Engineering Mechanics, Dhanpat Rai Publication, New Delhi
6. S. Rajshekharan, Engineering Mechanics, VIkas Publishing House , New Delhi

Subject Code : MEP-511
Title of the course : ENGINEERING MECHANICS

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the basic laws of Engineering Mechanics
CO2: Calculate and analyze the various forces acting on engineering component
CO3: Solve complex Engineering problems by applying mechanics laws
CO4: Analyze various forces acting on elements of truss
CO5: Understand and analyze the kinetics of particle

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	3	2	3	2	2	2	3	2	3	2	2	2	1	-
CO2	2	3	3	2	3	3	3	2	3	2	3	3	1	-	1
CO3	2	2	3	3	2	2	2	3	2	3	2	2	1	2	2
CO4	2	3	3	3	3	3	2	3	3	2	3	2	2	1	-
CO5	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
Average	2.4	2.6	2.8	2.6	2.6	2.4	2.2	2.6	2.6	2.4	2.4	2.2	1.4	1.5	1.333 33

List of experiments ENGINEERING MECHANICS LAB (MEP-511)

L	T	P	Credits	Weekly Load
0	0	2	1	2

1. To verify parallelogram law of forces addition.
2. To verify triangular law of forces addition.
3. To verify Lamis theorem.
4. To determine efficiency of screw jack.
5. To determine coefficient of friction on horizontal surface.
6. To determine coefficient of friction on inclined plane.
7. To calculate moment of inertia of a body.
8. To determine center of gravity of a 3 dimensional body.
9. To determine efficiency of wheel and Axle.

Subject Code : MET-512
Title of the course : BASIC ENGINEERING THERMODYNAMICS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Able to identify the various types of engines along with their working.
CO2: Able to conduct experiments on performance analysis of engines.
CO3: Develop the basic knowledge the steam engines/ steam nozzle/ steam turbine.
CO4: Able to conduct experimentation on performance analysis of jet propulsion/ compressors.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	2	3	2	3	2	2	2	2	1	1
CO2	3	3	3	3	1	3	2	3	2	3	2	3	1	2	1
CO3	3	3	3	2	2	3	2	2	2	2	3	2	1	2	2
CO4	3	3	3	2	2	3	2	3	3	3	2	2	2	1	2
Average	3	3	2.75	2	2	2.75	2.25	2.5	2.5	2.5	2.25	2.25	1.5	1.5	1.5

Theory

Course Description	Lectures
Unit-I	
Internal Combustion Engines	
Introduction to I.C. Engines and their classification, Engine components, Nomenclature, Comparison of S.I. & C.I. engine, Working principles of 2-stroke and 4-stroke engine, Comparison of 2-stroke and 4-stroke engine, Gas power cycle, Introduction of different cycles, Carnot cycle, Otto, Diesel cycle, Dual cycle. Analysis of Otto cycle, Diesel cycle & Dual cycles.	**7**
Combustion in S.I. Engine	
Introduction, Combustion in S.I. engine, Flame front propagation, Factor influencing flame speed, pre-ignition, abnormal combustion, Phenomena of knock in S.I. engine, Effect of engine variables on knocking.	**7**
Combustion in C.I. Engine	

Stages of Combustion in C.I. engine, Factors affecting delay period, Phenomena of knocking in C.I. engine, Comparison of knocking in S.I. & C.I. engine	**6**
Steam Engines:	
Parts of steam engine and their function, Working of steam engine, Indicator diagram (Theoretical & actual), Diagram factor, IHP, BHP, Mechanical efficiency, Compounding of steam engines.	**4**
Steam Nozzles and Steam Turbines:	
Introduction to nozzles & types, Equation of continuity, Steady flow energy equation, Momentum equation, Nozzle efficiency, Calculation of nozzle area in adiabatic and frictionless flow, Mass flow rate through nozzle. Steam Turbines:Rankine's cycle, Principle of operation of steam turbine, Types of steam turbines, Simple impulse turbine, Compounding of impulse turbine, impulse reaction turbine, Reaction turbine, Velocity diagram of impulse turbine, effect of blade friction on velocity diagram, Blade or diagram efficiency, gross stage efficiency.	
Gas Turbines:	**8**
Simple open cycle gas turbine, Actual Brayton's cycle, Rate & work ratio, Open cycle gas turbine with regeneration, Open gas turbine cycle with reheat, Open gas turbine with inter cooler, Comparison between closed cycle gas turbine & open cycle gas turbine, advantages & disadvantages of gas turbine over steam turbine, application of gas turbine.	**7**
Jet Propulsion	
Introduction to turbojet engine, Thrust power propulsive efficiency, Thermal efficiency relations, Advantages & disadvantages of jet propulsion over other system, Operation of rocket engine using solid, Liquid propellant.	**4**
Compressors	
Types of compressors, Reciprocating, centrifugal, screw comp. etc., Work done in single & multi cylinder compressor, Inter-cooling, Principle of minimum work for multi compressor, Efficiency.	**5**

Total-48

Recommended Books

Title	**Author(s)**	**Publisher**
I.C. Engine	Mathur& Sharma	Dhanpat Rai & Sons
Thermodynamics	P.K.Nag	TMH
Thermodynamics (Vol. I-	R.Yadav	CPH

III)

Heat Engineering	V.P.Vasandhani	Khanna Pubilsher
Thermal Engineering	P.L.Ballaney	Khanna Pubilsher
Engineering Thermodynamics	O.P.Single	TMH

Subject Code : MEP-512
Title of the course : BASIC ENGINEERING THERMODYNAMICS LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Able to identify the various types of engines along with their working.
CO2: Able to conduct experiments on performance analysis of engines.
CO3: Develop the basic knowledge the steam engines/ steam nozzle/ steam turbine.
CO4: Able to conduct experimentation on performance analysis of jet propulsion/ compressors.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	2	3	2	3	2	2	2	2	1	1
CO2	3	3	3	3	1	3	2	3	2	3	2	3	1	2	1
CO3	3	3	3	2	2	3	2	2	2	2	3	2	1	2	2
CO4	3	3	3	2	2	3	2	3	3	3	2	2	2	1	2
Average	3	3	2.75	2	2	2.75	2.25	2.5	2.5	2.5	2.25	2.25	1.5	1.5	1.5

List of Experiments APPLIED THERMODYNAMICS LAB

1. Constructional details and working of 2-stroke petrol engine.
2 Constructional details and working of 4-stroke petrol engine.
3. Constructional details and working of 4-sytokr diesel engine.
4. To find the performance of a diesel engine (B.H.P, thermal efficiency, fuel consumption, air consumption.)
5. Make a heat balance sheet of 4-stroke single cylinder diesel engine.
6. Morse test on 4-stroke 4 cylinder petrol engine.
7. To Analyses the exhaust gases of a vehicle with the help of a exhaust gas analyses.
8. To find out the flash point and fire point of kerosene.
9. Constructional details and working of steam engine.
10. Constructional details and working of turbojet engine.

Subject Code : MET-513
Title of the course : MANUFACTURING PROCESS I

PROCESSES

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: select and use different cutting tools for various operations such as turning drilling etc
CO2: identify and use of various presses and related operations
CO3: understand metal finishing operations such as metal spraying & coating etc.
CO4: know basics of various powder metallurgy aspects
CO5: understand various gear manufacturing methods

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	2	3	2	3	2	2	1	1	1
CO2	2	3	3	2	3	3	3	2	3	2	3	3	2	2	1
CO3	2	2	3	3	2	2	2	3	2	3	2	2	1	2	3
CO4	2	3	3	3	3	3	2	3	3	2	3	2	2	1	2
CO5	3	2	3	2	3	2	2	2	3	2	2	2	2	1	3
Average	2.4	2.6	2.8	2.6	2.6	2.4	2.2	2.6	2.6	2.4	2.4	2.2	1.6	1.4	2

Theory

Course Description	**Lecture(s)**
Unit-I	
Cutting Tools	**08**
Types of cutting tools, cutting tool materials and their properties, illustration of different cutting tools, design and manufacturing of a single point cutting tool, a twist drill and milling cutters.	
Press Working	**08**
Types of presses, press working operations; shearing, blanking, piercing, coining, swaging, embossing and upsetting. Types of dies, punches. punch holders & strip Layout	
Metal Finishing and Coating	**08**

Purpose of grinding, surface grinding, cylindrical grinding, centre-less grinding, specifications of grinding wheel, super finishing, introduction to Honing, Lapping Polishing, Buffing and super-finishing. Metal Spraying. Metal Coating; galvanizing, electro-plating and anodizing.	
Unit-II	
Powder Metallurgy	**06**
Principle. Methods of making powder from metal. Processes involved; Compacting, Sintering and finishing operations. Advantages and Disadvantages of powder metallurgy	
Thread Manufacturing	**08**
Introduction, types of threads, threads making techniques, thread cutting on a lathe, threads finishing.	
Gears and Gear Manufacturing	**10**
Gear nomenclature, types of gears and their applications, gear manufacturing methods, gear cutting on a milling machine, gear hobbing, gear shaping and gear finishing	

Total = 48

Recommended Books

Title	***Author(s)***	***Publisher***
Manufacturing Science	Malik & Ghosh	EWP
Production Engineering Science	Pandey & Singh	Standard Publishers
Metal cutting Theory	A.Bhattacharya	Central Book publishers

Subject Code : MET 516
Title of the course : Fluid Mechanics and Machinery

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: To learn fluid properties, types of fluid and to apply this knowledge for understand of static fluid behaviour.
CO2: Understand the principles of submerged surface and floating surfaces
CO3: Understand the kinematics and dynamics of fluid flow
CO4: Differentiate between various turbines and its principle.
CO5: Understand mechanics of various pumps and its characteristics

**Pre-requisite knowledge: **

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	2	3	2	3	2	1	3	1	2	2
CO2	3	2	3	3	3	2	3	3	2	3	2	3	2	3	1
CO3	2	3	3	2	2	1	2	2	2	3	2	3	3	1	2
CO4	3	3	3	3	3	3	2	3	2	2	1	2	1	2	3
CO5	2	1	2	3	3	3	2	2	2	2	2	3	1	2	2
Average	2.6	2.4	2.8	2.6	2.6	2.2	2.4	2.4	2.2	2.4	1.6	2.8	1.6	2	2

Course Description	**Lectures**
Unit-I	
Fundamental concepts	
Definition of fluid, distinction between solid and fluid, fluid properties: viscosity, surface tension, capillarity, vapour pressure; types of fluid	**03**

Fluid statics	
Control volume, forces on fluid element, fundamental equation of fluid statics, pressure and devices for its measurement, centre of pressure, buoyancy, centre of buoyancy, metacentre, metacentric height, hydrostatic thrust on submerged bodies	**06**
Kinematics of fluid	
Scalar and vector fields, flow field and methods of describing fluid motion, classification of fluid flow, motion of fluid particle along a curved path, velocity and acceleration of fluid particle, rate of discharge, continuity equation in differential form in different co-ordinate systems, velocity potential, rotation, circulation, vorticity, stream lines, path lines, streak lines, stream function, flow net, conservation of momentum- equation of motion and momentum theorem	**06**
Dynamics of fluid flow	
Fluid dynamics, control volume and control surface, energy and its different form used in fluid mechanics, Euler's equation of motion, Bernoulli's theorem, application of Bernoulli's theorem, Euler's equation along a streamline, Application of Bernoulli's theorem.	**06**
UNIT II	
Impact of jet	
Dynamic force exerted by fluid jet on stationary/ moving, vertical, inclined, flat and curved plates.	**03**
Pelton Wheel and impulse turbine	
Element of hydroelectric power plant, efficiencies of hydraulic turbines; Classification of turbines. Pelton wheel turbine, main component and their function, turbine power, nozzle and jet diameter, No. of jets, mean diameter of a Pelton runner, selection of a speed, jet ratio, minimum no. of buckets and other impulse turbine. Design of Pelton turbine runner. Force, power and efficiency. Unit and specific quantities, Specific speed.	**06**
Reaction turbine,	
Francis turbine, work done and efficiency of Francis turbine, Design of Francis turbine runner. Kaplan turbine, work done & efficiency of Kaplan turbine, Cavitation's and its effect. Draft tube theory and it's type, efficiency of draft theory.	**05**
Reciprocating pumps	
classifications, main parts of a reciprocating pumps, working principle. Discharge, work done and power requirement in a reciprocating pump. slip of a reciprocating pump.	**04**

Effect of accelerating of piston on velocity and acceleration in the suction and delivery pipe. Indicator diagram. Air vessel.	
Centrifugal pumps	
working principle and operation, classification, Main components, discharge, Head of a pump , power , determination loss of head in pipe line and pipe fitting. Efficiencies of Centrifugal pump. Priming of pump. Cavitation in pumps. Net positive section head. Selection of a centrifugal pump.	**05**

Total=44

Recommended Books:

1. White, Fluid Mechanics, ,McGraw Hill
2. Munson , Fundamentals of Fluid Mechanics, John Wiley & Sons
3. Cenegal, Fluid Mechanics, McGraw Hill
4. Modi & Seth, Fluid Mechanics & Fluid Machines, Standard Publishers
5. D. S. Kumar, Fluid Mechanics & Fluid Machinery, Kataria& Sons
6. A.K Jain, Fluid Mechanics, Khanna Publishers
7. Om & Biswas, Fluid Mechanics & Fluid Machines, Tata McGraw-Hill.
8. J. Lal, Fluid Mechanics, Metropolitan.

Subject Code : MEP- 516
Title of the course : Fluid Mechanics and Machinery Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: To learn fluid properties, types of fluid and to apply this knowledge for understand of static fluid behaviour.
CO2: Understand the principles of submerged surface and floating surfaces
CO3: Understand the kinematics and dynamics of fluid flow
CO4: Differentiate between various turbines and its principle.
CO5: Understand mechanics of various pumps and its characteristics

**Pre-requisite knowledge: **

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	2	3	2	3	2	1	3	1	2	2
CO2	3	2	3	3	3	2	3	3	2	3	2	3	2	3	1
CO3	2	3	3	2	2	1	2	2	2	3	2	3	3	1	2
CO4	3	3	3	3	3	3	2	3	2	2	1	2	1	2	3
CO5	2	1	2	3	3	3	2	2	2	2	2	3	1	2	2
Average	2.6	2.4	2.8	2.6	2.6	2.2	2.4	2.4	2.2	2.4	1.6	2.8	1.6	2	2

List of Experiments

1. Determination of Viscosity of a Liquid by Redwood viscometer.
2. Verification of Bernoulli's Theorem.
3. To determine Coefficient of Discharge of Venturimeter.
4. To determine Coefficient of Discharge of orifice meter.
5. To determine Coefficient of Discharge of Weir.
6. To study the constructional details of a Pelton turbine and measure its efficiency.
7. To study the constructional details of a Francis turbine, Kaplan turbine
8. To study the constructional details of a Centrifugal Pump and measure its efficiency
9. To study characteristics curves of Reciprocating Pump.

Subject Code : MEP-515

Title of the course : MACHINE DRAWING

L	T	P	Credits	Weekly Load
0	0	4	2	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Recall the concept of basicengineering drawing

CO2: Understand and represent a machine component or machine by lines according to certain set rules

CO3: Understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.

CO4: Use the techniques, skills and modern engineering tools necessary for creating and assembling with the concept of virtual work.

CO5: Design a system, component or process to meet desired needs within, realistic constraints such as manufacturability ,economic ,environmental, safety & sustainability etc.., to represent a part drawing and assembly drawings.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	1	2	1	1	3	2	1	1
CO2	3	3	2	2	3	1	1	1	2	3	1	3	2	3	1
CO3	3	2	2	1	3	1	1	1	1	3	2	2	1	3	2
CO4	2	2	3	2	1	1	1	1	2	1	2	2	2	1	2
CO5	2	2	2	1	1	1	1	1	1	1	1	2	1	1	1
Average	2.6	2.2	2.2	1.6	1.8	1	1	1	1.6	1.8	1.4	2.4	1.6	1.8	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Basics of Machine Drawing	**04**
Machining symbols, surface finish characteristics, surface roughness symbols, limits, fits and tolerances.	

Screw Threads	**06**
Screw thread nomenclature, thread designation, conventional representation of screw threads, different types of threads and their representation.	
Fastenings	**08**
Nut, bolt and washer; types of nuts, types of bolts, Welding; types of welded joints, representation of a weld, welding symbols according to B.I.S.	
Unit-II	
Keys, Cotters and Joints	**08**
Introduction, proportions of a key, types of keys and their applications. A Cotter and a Gib with their uses. Types of joints used for connecting rods.	
Rivets and Riveted Joints	**08**
Types of rivets, types of riveted joints, general terms/rules used for riveted joints.	
Assembly and detail drawings	**14**
One assembly drawings of a Tail stock, details (drawings of different elements) of a screw jack assembly.	

Total = 48

Recommended Books

Title	***Author(s)***	***Publisher***
Machine Drawing	N D Bhatt	Khanna
Machine Drawing	P S Gill	Standard
Machine Drawing	R.K. Dhawan	S. Chand
Machine Drawing	GoutamPohit& Goutam Ghosh	Pearson Education

Subject Code : MET-521
Title of the course : Physical Metallurgy and Heat Treatment

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understanding crystal structure, solid solutions and its types, component, solubility limit, diffusion in solids.

CO2: Learning about the Crystal defects and their classifications, edge and screw dislocations, stress strain relationship, plastic deformation by slip & twinning, review of strengthening mechanisms.

CO3: Need and importance of phase diagram, unary & binary phase diagrams, Allotropic transformation of iron and steel, analysis of phase diagrams, Iron carbon equilibrium diagram.

CO4: Select a suitable heat treatment process for a given application.

CO5: Understand various hardening process.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	3	3	2	2	1	2	2	1	2
CO2	3	2	3	2	2	2	2	2	3	2	2	2	2	2	1
CO3	3	3	3	3	2	2	3	2	2	3	2	2	1	2	3
CO4	3	2	3	2	3	2	2	3	2	3	1	2	2	1	2
CO5	3	3	3	3	2	2	1	3	2	2	1	3	2	1	3
Average	3	2.4	3	2.4	2.2	2	2.2	2.6	2.2	2.4	1.4	2.2	1.8	1.4	2.2

Theory

Course Description	Lecture(s)
Unit-I	
Structure of solids	**06**
Introduction to metals, non metals and alloys, crystal structure, solid solutions and its types, component, solubility limit, diffusion in solids.	
Plastic deformation and work hardening	**08**
Crystal defects and their classifications, edge and screw dislocations, stress strain relationship, plastic deformation by slip & twinning, review of strengthening mechanisms.	
Phase Transformation I	**10**
Phase diagram: Introduction, importance and objectives of phase diagram, unary & binary phase	

diagrams, Allotropic transformation of iron and steel, cooling curves, Gibbs's phase rule, Lever rule, common types of phase diagram: eutectic and eutectoid systems, peritectic and peritectoid systems, Properties of austenite, ferrite, pearlite, martensite.	
Unit-II	
Phase Transformation II	**10**
Introduction, Nucleation and Growth, Ingot structure, solidification and crystallization, recovery, re-crystallization and grain growth, Iron carbon equilibrium diagram, Transformation of austenite to pearlite , Transformation of austenite at constant temperature: time temperature transformation (TTT), continuous cooling transformation (CCT).	
Heat Treatment:	**08**
Heat Treatment: Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering. harden ability.	
Surface Hardening	**06**
Carburizing: Gas, Pack, Liquid, Nitriding, cyaniding, flame and induction hardening. Surface hardening applications	

Total=48

Recommended Books:

	Title	*Author(s)*	*Publisher*
1.	Engg. Phy. Metallurgy &Heat Treatment	Yuri Lakhtin	Mir Publishers
2.	Physical Metallurgy	Donalk S Clark	East West Press
3.	Material Science and Engineering	Raghvan	PHI
4.	Heat treatment principles and applications	Rajan and Sharma	PHI
5.	Physical metallurgy handbook	McGRAW Hill	Anil Kumar Sinha

Subject Code : MEP-521
Title of the course : Physical Metallurgy and Heat Treatment Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understanding crystal structure, solid solutions and its types, component, solubility limit, diffusion in solids.

CO2: Learning about the Crystal defects and their classifications, edge and screw dislocations, stress strain relationship, plastic deformation by slip & twinning, review of strengthening mechanisms.

CO3: Need and importance of phase diagram, unary & binary phase diagrams, Allotropic transformation of iron and steel, analysis of phase diagrams, Iron carbon equilibrium diagram.

CO4: Select a suitable heat treatment process for a given application.

CO5: Understand various hardening process.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	3	3	2	2	1	2	2	1	2
CO2	3	2	3	2	2	2	2	2	3	2	2	2	2	2	1
CO3	3	3	3	3	2	2	3	2	2	3	2	2	1	2	3
CO4	3	2	3	2	3	2	2	3	2	3	1	2	2	1	2
CO5	3	3	3	3	2	2	1	3	2	2	1	3	2	1	3
Average	3	2.4	3	2.4	2.2	2	2.2	2.6	2.2	2.4	1.4	2.2	1.8	1.4	2.2

List of Experiments

1. Introduction to the crystal lattice of solids.
2. Familiarization and specimen preparation with the following examinations
   i. Macro examination of specimens of ferrous materials.
   ii. Micro examination of specimens of ferrous materials
   iii. Macro examination of specimen of non-ferrous material.
   iv. Micro examination of specimen of non-ferrous material.
3. To carry out microstructural studies on different steel specimens e.g. cast specimens, welded specimens etc.
4. Study the effect of varying cooling rate on the microstructure of steel and comparing in terms of grain size and mechanical properties.
5. To carry out following heat treatments of the given steel specimen
   i. Annealing.,
   ii. Normalizing

iii. Hardening

6. To conduct following case hardening treatment of the given specimen.
   i. Carburizing.
   ii. Flame hardening.
7. Analysis of the microstructural changes in the specimens after giving different heat treatments as above.
8. Familiarization with the codification of steels and other alloys.

Title of the course : **Conventional Welding Processes**

Subject Code : **MET-526**

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals to solve welding problems.
CO2: Should be able to select a suitable welding process for a particular application.

CO3: Understand the impact of welding operations on environment
CO4: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines

Pre-requisite knowledge: Nil

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	1	1	2	2	3	1	2
CO2	2	2	2	1	1	1	2	3	2	3	1	1
CO3	3	3	2	1	1	1	1	3	3	3	2	2
CO4	2	2	2	1	1	1	2	2	2	3	2	1
Average	2.25	2.25	2	1	1.25	1	1.5	2.5	2.25	3	1.5	1.5

Theory

Course Description	Lecture(s)
Unit-I	

Introduction to Welding Processes	
Definition, Terms used in welding, Advantages, Classification of welding processes and their principles in brief with applications.	**04**
Gas Welding	
Introduction & principle of gas welding, Different gases used & their properties, Types of flames, Welding technique and safety Applications of the process.	**04**
Brazing and Soldering	
Difference between brazing and soldering, braze welding, Wetting and spreading characteristics, surface tension and contact angle concept, introduction to different brazing and soldering methods (torch, furnace, brazing and soldering consumables, application of brazing and soldering.	**06**
Shielded metal arc Welding	
Electric arc, arc starting methods, Arc stability, arc efficiency, arc blow, power sources, VI characteristics of power source, electrode polarity, duty cycle, classification and coding of SMAW electrodes.	**10**
Unit-II	
Gas tungsten arc welding	
Gas tungsten arc welding- Principle, Equipments used and welding parameters, Shielding gases and their effect, Advantages, Disadvantages and Applications of the process.	**06**
Gas metal arc welding	
Gas metal arc welding- Principle, Equipments used and variables, Shielding gases and their effect on bead geometry, Mode of metal transfer and pulse MIG, Flux core arc welding and CO_2 Welding, Applications of the process.	**06**
Submerged Arc Welding	
Submerged arc welding- Principle, equipments used, welding parameters, SAW fluxes, classification, flux- wire combination, Multi wire, strip cladding and narrow gap welding Applications of the process.	**06**
Resistance Welding	
Basic principle, brief introduction to spot, seam, projection and flash butt welding, welding variables, resistance welding equipments, heat balance, applications.	**06**

Total=48

Recommended Books:

1. Welding Processes and Technology by R.S Parmar (Publisher: Khanna Publishers)
2. Modern Arc Welding Technology by S.V. Nadkarni (Publisher: Oxford & IBH)
3. Modern Arc Welding Technology by Hobart B. Cary (Publisher; Prentice Hall Cambridge Univ. Press)

Title of the course : **Conventional Welding Processes**

Subject Code : **MEP-526**

L	T	P	Credits	Weekly Load
0	0	6	1	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals to solve welding problems.
CO2: Should be able to select a suitable welding process for a particular application.

CO3: Understand the impact of welding operations on environment
CO4: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines

Pre-requisite knowledge: Nil

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	1	1	2	2	3	1	2
CO2	2	2	2	1	1	1	2	3	2	3	1	1
CO3	3	3	2	1	1	1	1	3	3	3	2	2
CO4	2	2	2	1	1	1	2	2	2	3	2	1
Average	2.25	2.25	2	1	1.25	1	1.5	2.5	2.25	3	1.5	1.5

List of experiments

(8-10 experiments from the following list)

1. Introduction to lab and safety aspects regarding arc and gas welding.
2. To study the equipment for gas welding.
3. Identification of various flames in gas welding.

4. To practice with gas welding equipment.
5. To practice soldering and brazing.
6. To study the power sources for arc welding processes.
7. To practice bead on plate experiment using SMAW process.
8. To study the effect of electrode polarity on bead characteristics.
9. To practice bead on plate experiment using GMAW process.
10. To practice bead on plate experiment using GTAW process.
11. To practice bead on plate experiment using SAW process.
12. To study the equipment for resistance welding. (spot/projection/flash butt etc.)
13. To perform nugget test for spot welding.
14. To perform flash butt welding.

Subject Code : MET-523
Title of the course : Strength of Materials

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to

CO1: Apply the basic concepts and principles of strength of materials.

CO2: Calculate stresses and deformations of objects under external loadings.

CO3: Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
CO4: Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
CO5: Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
CO2	2	3	2	2	2	3	3	2	2	3	2	3	2	2	1
CO3	2	2	2	3	3	2	3	3	3	2	3	2	1	2	2
CO4	2	2	2	2	3	3	3	2	2	2	2	2	2	1	2
CO5	3	3	2	2	2	2	2	2	2	2	2	3	2	1	1
Average	2.4	2.4	2.2	2.2	2.6	2.4	2.6	2.2	2.4	2.2	2.2	2.4	1.6	1.6	1.4

Theory

Course Description	Lecture(s)
Unit-I	

PROPERTIES OF MATERIAL*:* Introduction, uni-axial tension test, idealized stress-strain diagrams, isotropic linear elastic, visco-elastic and plastic materials, compression test, impact test, fatigue test, torsion and bending test	**03**
SIMPLE STRESS & Strain Concept of stresses and strains, relationship between elastic constants, Modulus of elasticity stresses and strains in bars subjected to axial loading, , stress produced in compound bars subjected to axial loading.Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound walls. Extension of uniform bar & tapered bar under its own weight and due to load applied,	**05**
COMPOUND STRESSES AND STRAIN Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications. Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain. Relationship between elastic constants. principal stresses determined from principal strain	**04**
SHEAR FORCE AND BENDING MOMENT IN BEAMS Relation between unit load, Force and Moment. Shear Force and Bending Moment diagram of beams under various types of loading for cantilevers, simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.	**08**
Theory of bending stresses simple bending theory, derivation of bending formula: its application to beams of various sections (rectangular, circular and channel, etc) Shear Stresses- Derivation of formula ,Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections, Composite beams, bending and shear stresses in composite beams	**06**
Unit-II	
Slope & DEFLECTION OF Beams Relationship between moment, slope and deflection Deflection by calculus, Macaulay's methods, Moment area method, method of deflection coefficient, deflection due to shear of various beams under the action of various loading conditions; built in and propped beam.	**06**
Torsion Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, Torsional rigidity., Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs.	**04**
Thin Cylinders and Spheres Derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures.	**04**

Columns and Struts Definitions and examples of instability; criteria for stability of equilibrium, Euler's theory of columns, Slenderness ratio. equivalent length Columns under uni-axial load, buckling, Euler's equation for various end restraints, Rankine formula, eccentrically loaded struts, struts with initial curvature, lateral stability of beams; struts with lateral loading Buckling of Columns,.RankineGordon‟s empirical formula	**08**

Total=48

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Recommended Books

Title	**Author(s)**	**Publisher**
Mechanics of Solids	Popov	PHI
Strength of Materials	Sadhu Singh	Khanna
Strength of Materials	Ryder G.H	ELBS
Mechanics of Solids	Gambhir	PHI
Strength of Materials	R. S. Lehri	Kataria
Strength of Materials	Pytel A H and Singer F L	Harper Collins, New Delhi.

Subject Code : MEP-523
Title of the course : Strength of Materials Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:
After successful completion of course, the students should be able to

CO1: Apply the basic concepts and principles of strength of materials.

CO2: Calculate stresses and deformations of objects under external loadings.

CO3: Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
CO4: Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
CO5: Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
CO2	2	3	2	2	2	3	3	2	2	3	2	3	2	2	1
CO3	2	2	2	3	3	2	3	3	3	2	3	2	1	2	2
CO4	2	2	2	2	3	3	3	2	2	2	2	2	2	1	2
CO5	3	3	2	2	2	2	2	2	2	2	2	3	2	1	1
Average	2.4	2.4	2.2	2.2	2.6	2.4	2.6	2.2	2.4	2.2	2.2	2.4	1.6	1.6	1.4

List of Experiments Strength of Materials lab(MEP-523)

1. Tension test

2. Bending tests on simply supported beam / Cantilever beam.
3. Torsion test
4. Hardness tests (Brinell and Rockwell)
5. Tests on closely coiled and open coiled springs
6. Compression test on wood or concrete
7. Impact test
8. Shear test
9. Fatigue Test

Title of the course : **Safety in welding**

Sub code : MET-527

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to:

CO1: Understand various aspect of safety engineering

CO2: Gainknowledge about industrial safety and hazards

CO3: Able to calculate costing of accidents and hazards

CO4: Understand basic job safety analysis

CO5: Able to understand Techniques of safety Management and safety performance Planning

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	2	2	3	3	2	2	2	1	1	1	1	1
CO2	2	1	1	2	2	2	3	1	2	2	1	1	1	1	1
CO3	2	2	2	2	2	2	3	1	3	2	3	1	2	1	2
CO4	1	1	2	2	1	2	2	1	2	2	1	2	1	1	1
CO5	3	3	2	2	2	2	2	1	3	3	2	2	2	1	1
Average	1.8	1.6	1.6	2	1.8	2.2	2.6	1.2	2.4	2.2	1.6	1.4	1.4	1	1.2

Course Description	Lecture(s)
Unit -1	

Concept of safety	
Introduction, Definitions, Need of safety, Importance of safety, Factors affecting safety, safety and productivity.	05
Safety regulations	
Safety act, laws of safety, Introduction to The Factories Act 1948, Factories act amendments in 1987	07
First Aid	
Concept of first aid, Essential features of first aid, Training in first aid, first aid kits, qualified first aider.	04
Safety in welding	
Causes of hazard associated with gas and arc welding processes. Protections against electric shock, arc radiations, fumes and dust, compressed gases, fire and explosions.	08
Unit-II	
Safety precautions against fire	
Causes of industrial fire, elements of fire, preventive measures to be taken against fire, handling of the fire accidents, fire fightingequipments.	06
Safety management technique	
Safety inspections, procedures, periodicity, checklist, report form, planning for safety, Safety engineer, responsibilities of safety engineer, safety committee.	06
Safety equipments	
Various safety equipments, constructural features, handling, maintenance and repairs of safety equipments, Personnel protective equipments.	04
Safety during Welding operations	
Special precautions to be taken during welding and cutting operations like welding in confined spaces, welding of used containers, under water welding, plasma welding, welding of non ferrous metals.	08

Total: 48

Recommended Books:

Title	Author	Publisher
1. Manufacturing management	Moore	MGH
2. Industrial Engineering	OP Khanna	Dhanpat Rai
3. Hand Book of Industrial Engineering	Maymard	MGH
4. Welding Process and Tech.	RS Parmar	Khanna

Subject Code : MET-525
Title of the course : Kinematics of Machines

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the working of various machines and mechanisms

CO2: Synthesize the mechanism using various mathematical techniques.

CO3: Formulate and construct the cam profile for a particular application.

CO4: Analyze and suggest the suitable power transmission mechanism between two shafts.

CO5: Distinguish the suitable gear for a particular application, Understand different motions with in a gear box and importance of different parts of a gear box.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
CO2	2	3	2	2	2	3	3	2	2	3	2	3	2	2	1
CO3	2	2	2	3	3	2	3	3	3	2	3	2	1	2	2
CO4	2	2	2	2	3	3	3	2	2	2	2	2	2	1	2
CO5	3	3	2	2	2	2	2	2	2	2	2	3	2	1	1
Average	2.4	2.4	2.2	2.2	2.6	2.4	2.6	2.2	2.4	2.2	2.2	2.4	1.6	1.6	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Review of Mechanism & Machine	
Concepts and classification of links, pairs, kinematic symbols, kinematic chains, plane motion; Constraints and degrees of freedom, mechanism and machines, inversion, conversion of mechanisms.	**08**
Kinematic Analysis	
Kinematic quantities and their relationships, absolute and relative motions and their vector	**10**

representation, instantaneous centers, Kennedy's theorem; Relative velocity method, method of instantaneous centres, resolution and orthogonal velocity methods; Acceleration analysis, Coriolis acceleration, mathematical analysis of slider crank mechanism, special graphical methods; Klein's construction, Ritterhau construction & Bennet construction for velocity & acceleration analysis of single slider crank mechanism.	
Motion Synthesis	
Graphical methods of synthesis, Chebyshev spacing, two position synthesis, application to four bar mechanism, analytical synthesis using complex algebra, Freudensteins method.	**06**
Unit-II	
Applied Linkages	
Radial engines and mater crank, straight line motion and indicator mechanisms, steering mechanisms, quick return mechanisms, intermittent motion mechanisms, Geneva mechanism, analog computing mechanisms, various types of ingenious mechanisms and their functioning.	**06**
Cams	
Classification, types of motion curves and their analytical expressions, graphical construction of cam profiles for different types of followers, pressure angle and cam size, cams with specified contours.	**08**
Belt, Rope & Belt Drive	
Introduction, flat and V-belt drive, velocity ratio, Creep, slip in belt drive, velocity law, compression in belt, tension in belt, and angle of contact, power transmission. Belt, chain and rope drive.	**06**
Gears	
Introduction, Classification. Terminology. Law of Gearing Spur Gear; velocity of sliding in mating teeth. Involute and Cycloidal teeth & their construction and comparison. Involute Profile Gears; Length of path of contact, Contact Ratio, Interference, number of teeth on wheel, pinion & rack to avoid interference. Introduction to helical and worm gears.	**04**

Total=48

Recommended Books:

1. Martin, G.H., "Kinematics and Dynamics of Machines", 3rd Ed., McGraw-Hill, 1982
2. Ghosh, A., and Mallik, A.K., "Theory of Mechanisms and Machines", 2nd Ed., Affiliated East-West Press, 2003.
3. Bevan, T., "Theory of Machines", 3rd Ed., CBS Publishers 2003.
4. Vicker, J.J., Shigley, J.E., and Penock, G.R., "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press, 2003.
5. Hannah, J., and Stephens, R.C., "Mechanics of Machines: Elementary Theory and Examples", 4th Ed., Viva Books, 2004.
6. Rattan S.S., "Theory of Machines", TMH, New Delhi, 2010.

Subject Code : MEP-525
Title of the course : Kinematics of Machines Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the working of various machines and mechanisms

CO2: Synthesize the mechanism using various mathematical techniques.

CO3: Formulate and construct the cam profile for a particular application.

CO4: Analyze and suggest the suitable power transmission mechanism between two shafts.

CO5: Distinguish the suitable gear for a particular application, Understand different motions with in a gear box and importance of different parts of a gear box.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
CO2	2	3	2	2	2	3	3	2	2	3	2	3	2	2	1
CO3	2	2	2	3	3	2	3	3	3	2	3	2	1	2	2
CO4	2	2	2	2	3	3	3	2	2	2	2	2	2	1	2
CO5	3	3	2	2	2	2	2	2	2	2	2	3	2	1	1
Average	2.4	2.4	2.2	2.2	2.6	2.4	2.6	2.2	2.4	2.2	2.2	2.4	1.6	1.6	1.4

List of Experiments Kinematics of Machines lab

1. Study of kinematic pairs and kinematic chain.
2. Study of different kinds of planar mechanism; four bar mechanism, single slider crank mechanism, double slider mechanism.
3. Construction of velocity and acceleration diagram for planar mechanism.
4. Demonstration of different kinds of CAM and Follower arrangements.
5. Construction of CAM with different types of followers for various kind of motion.
    a. Knife edge follower with various kind of motion.
    b. Roller follower with various kind of motion.
    c. Flat faced follower with various kind of motion.

   d. Spherical faced follower with various kind of motion.
6. Demonstration of different types of Gears.
7. Generation of profile of Gear teeth
   a. For Involute profile
   b. For Cycloidal profile.

Title of the course : Numerical Analysis

Subject Code : AMT- 611

L	T	P	Credits	Weekly Load
3	1	0	4	4

CO1: Apply Numerical analysis which has enormous application in the field of Science and some fields of Engineering.

CO2: Familiar with numerical solutions of nonlinear equations in a single variable.

CO3: Familiar with numerical integration and differentiation, numerical solution of ordinary differential equations.

CO4: Familiar with calculation and interpretation of errors in numerical method.

CO5: Familiar with programming with numerical packages like MATLAB.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	1	1	1	1	2	2	2	1	2	2
CO2	2	2	1	2	1	1	1	1	1	1	1	2	2	3	1
CO3	2	3	3	2	2	1	2	2	2	3	2	3	3	1	2
CO4	3	3	3	3	3	3	2	3	2	2	1	2	1	2	3
CO5	2	1	2	3	3	3	2	2	2	2	2	3	1	2	2
Average	2	2	2.2	2.4	2	1.8	1.6	1.8	1.6	2	1.6	2.4	1.6	2	2

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	1. Errors	Errors in arithmetic operations and functions. Round-off error, truncation error. Absolute error. Relative error.	

		Percentage error. Principles of equal effect. Significant digits.	4
	2. Roots of equations	Intermediate value property. Bisection method. Method of false position. Secant Method. Newton-Raphson method. Iteration method. Convergence of these methods.	6
	3. Solution of linear equations	Gauss Elimination method (with and without partial pivoting). Gauss-Seidel, Jacobi's methods. Triangularization method.	5
	4. Eigenvalue	Rayleigh's power method for finding dominant eigenvalue.	4
	5. Finite differences	Finite differences-forward, backward and central differences. Shift and averaging operators.	4
Unit-2	6. Interpolation	Newton's forward, backward and divided difference interpolation formulae. Lagrange's formula. Gauss forward and backward difference interpolation formulae. Spline interpolation–quadratic and cubic.	7
	7. Numerical differentiation and integration	Numerical differentiation using Newton's forward and backward difference formulae. Numerical integration – Trapezoidal rule, Simpson's one third and three-eighth rules. Romberg's integration. Error in integration.	8
	8. Numerical solution of ODEs	Taylor series method. Picard's method. Euler method. Modified Euler's method. Runge-Kutta methods (upto fourth order) for solution of ODE of first order.	7
			Total=45

Recommended Books:

1. S.S. Sastry, Introductory Method of Numerical Analysis, PHI.
2. Gerald Wheatley, Applied Numerical Analysis, Pearsons Education.
3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Sc. and Engg. Computation.
4. J.H. Mathew, Numerical Methods for Maths., Science and Engg., PHI.

Title of the course : **Numerical Analysis Lab**

Subject Code : **AMP- 611**

L	T	P	Credits	Weekly Load
0	0	2	1	2

CO1: Solve nonlinear equations and system of linear equations.

CO2: Find largest eigen value of a square matrix.

CO3: Use various interpolation formulae.

CO4: Find numerical differentiation and integration.

CO5: Solve numerically by using various techniques.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	1	0	0	0	0	0	1	0	2	2	3	2
CO2	3	3	2	1	0	0	0	0	0	1	0	2	2	3	2
CO3	3	3	2	1	0	0	0	0	0	1	0	2	2	3	2
CO4	3	3	2	1	0	0	0	0	0	1	0	2	2	3	2
CO5	3	3	2	1	0	0	0	0	0	1	0	2	2	3	2
Average	3	3	2	1	0	0	0	0	0	1	0	2	2	3	2

List of Programmes

1. Finding roots of the equation $f(x) = 0$ using
   i) Bisection Method ii) Secant Method iii) Method of false position

2. Finding roots of the equation $f(x) = 0$ using
   i) Iterative Method ii) Newton - Raphson's Method

3. To check consistency and finding Solution of a system of linear algebraic equations using
   i) Gauss elimination Method ii) Gauss - Seidal Method iii) Jacobi Method

4. Interpolation using
   i) Newton's forward difference formula ii) Newton's backward difference formula

5. Interpolation using
   i) Newton's divided difference formula ii) Lagrange's interpolation formula

6. Numerical differentiation using
   i) Newton's forward interpolation formula ii) Newton's backward interpolation formula

7. Numerical Integration using
   i) Trapezoidal rule ii) Simpson's $1/3^{rd}$ rule
   iii) Simpson's $3/8^{th}$ rule

8. Solution of I^{st} order ordinary differential equations using
   i) Taylor's series method ii) Picard's method
   iii) Euler's method iv) Euler's modified method

9. Solution of I^{st} order ordinary differential equations using Runge-Kutta methods.

10. Fitting a curve using given data.
    i) linear curve ii) quadratic curve
    iii) cubic curve iv) any other

11. Finding the following, using given data:
    i) mean, median and mode.
    ii) standard deviation and mean deviation.
    iii) moments, skewness and kurtosis of various order.
    iv) rank correlation.

Subject Code : MET-611

Title of the course : Dynamics of Machines

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: To expand students knowledge of planar kinematic analyses of rigid body and simple, compound, reverted, epicyclical gear train systems.

CO2: To teach the student about the basic concepts of flywheel and governors and their applications to different situations.

CO3: To understand the basic laws of friction and its application to clutches, Power screws, brakes

CO4: Understandconcepts of static and dynamic mass balancing and concept of gyroscope

CO5: To understand the concepts of natural, damped and forced vibrations. Also apply it for solving complex problems of vibration

Pre-requisite knowledge:

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
CO2	2	3	2	2	2	3	3	2	2	3	2	3	2	2	1
CO3	2	2	2	3	3	2	3	3	3	2	3	2	1	2	2
CO4	2	2	2	2	3	3	3	2	2	2	2	2	2	1	2
CO5	3	3	2	2	2	2	2	2	2	2	2	3	2	1	1
Average	2.4	2.4	2.2	2.2	2.6	2.4	2.6	2.2	2.4	2.2	2.2	2.4	1.6	1.6	1.4

Course Description	**Lecture(s)**
Unit-I	
Gear Trains	
Introduction of simple, compound, reverted, epicyclic gear train & compound epicyclic gear train. Tooth load & torque in gear trains.	**04**
Force Analysis of Mechanisms	
Concept of free body and its equilibrium, static force analysis, friction effects, forces on gear teeth; D'Alembert's principle, dynamic force analysis, force analysis of cam-follower system, equivalent dynamical systems, dynamic analysis of reciprocating engines, practical examples from actual machines.	**04**

Flywheel	
Introduction, an approximate analysis, Fluctuation of energy and speed, energy in flywheel, calculation of flywheel size; Flywheel in punching, inertia force analysis of reciprocating engine.	**05**
Governors	
Type of governors, function of governors, Analysis of different types of governors, controlling force diagrams, sensitivity analysis, stability of governors, isochronous governors, hunting, power and efforts of governors.	**07**
Friction	
Introduction, law of friction, Coulomb friction, pivot and roller friction, flat pivot and conical pivot, flat collar pivot, single and multiple clutches, cone clutch.	**04**
Unit-II	
Friction Drives	
Introduction, Power screws, band and block brakes.	**04**
Balancing	
Balancing of rotating masses on one plane and in different parallel planes, balancing of slider crank mechanisms, balancing of in-line, V- and locomotive engines, principles of balancing machine.	**08**
Gyroscope	
Introduction. Principle of gyroscope. Gyroscopic couple. Direction of vector with forced precession. Analysis of precession due to forced precession of rotating disc mounted on shaft. Motion of rigid body with reference to Euler's equations. Effect of gyroscopic couple. Stability of two wheeler, four wheeler, sea vessels and aircraft with numerical problems.	**06**
Mechanical Vibration	
Simple harmonic motion; Conservative systems; Free vibrations of systems without damping; Equilibrium and energy methods for determining natural frequency; Rayleigh's method, free vibrations of system with viscous damping, over damped, critically and under damped systems, logarithmic decrement; Forced vibrations of systems with viscous damping, equivalent viscous damping; Impressed forces due to unbalanced masses and excitation of supports, vibration isolation, transmissibility.	**06**
	Total=48

Recommended Books:

1. Vicker, J.J., Shigley, J.E., and Pennock, G.R., "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press, 2003.
2. Vinogradov, O., "Fundamentals of Kinematics and Dynamics of Machines and Mechanisms", CRC Press, 2000.
3. Massie, H.H., and Reinholtz, C.F., "Mechanisms and Dynamics of Machinery", 4th Ed., John Wiley & Sons, 1987.
4. Grover, G.K., "Mechanical Vibrations", 7th Ed., Nem Chand and Brothers, 2003.
5. Thomson, W.T., "Theory of Vibration with Applications", 3rd Ed., CBS Publishers, 2003.
6. Rattan S.S., "Theory of Machines", TMH, New Delhi, 2010.

Subject Code : MEP-611
Title of the course : Dynamics of Machines Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: To expand students knowledge of planar kinematic analyses of rigid body and simple, compound, reverted, epicyclical gear train systems.

CO2: To teach the student about the basic concepts of flywheel and governors and their applications to different situations.

CO3: To understand the basic laws of friction and its application to clutches, Power screws, brakes

CO4: Understandconcepts of static and dynamic mass balancing and concept of gyroscope

CO5: To understand the concepts of natural, damped and forced vibrations. Also apply it for solving complex problems of vibration

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	1	2	1
CO2	2	3	2	2	2	3	3	2	2	3	2	3	2	2	1
CO3	2	2	2	3	3	2	3	3	3	2	3	2	1	2	2
CO4	2	2	2	2	3	3	3	2	2	2	2	2	2	1	2
CO5	3	3	2	2	2	2	2	2	2	2	2	3	2	1	1
Average	2.4	2.4	2.2	2.2	2.6	2.4	2.6	2.2	2.4	2.2	2.2	2.4	1.6	1.6	1.4

List of Experiments Dynamics of Machineslab(MEP-611)

1. Different types of Gear train.
2. Determination of moment of inertia for flywheel.
3. Different types of Governors.
4. Determination of height of Governor for varied spindle speed.
5. Demonstration of various types of Clutches and Brakes.
6. Determination of position and orientation of masses for balancing in different planes.

7. Demonstration of Gyroscope and determination of gyroscopic couple.
8. Demonstration of whirling of shaft.

Subject Code : MET-612C
Title of the course : Quality Reliability & Maintainability

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: Plot control charts for variables and attributes
CO2: Conduct inspection and control the process quality
CO3: Understand ISO standard & TQM approaches
CO4: Conduct reliability testing of products
CO5: Implement various types of maintenance strategies in the plant

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	2	1	1	1	1	1	1	2	1
CO2	3	3	3	3	3	1	2	2	1	3	2	1	3	2	1
CO3	3	3	3	3	3	1	2	1	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	2	1	1	1	1	1	1	2	1
Average	3	3	3	3	3	1	2	1.25	1	1.5	1.25	1	1.5	1.75	1

Theory

Course Description	Lecture(s)
Unit-I	
Quality Control Introduction, statistical control of processes, control charts for variables – X & R Charts, X & s Charts , properties of control charts, control charts for attributes – p chart, np chart, 100p chart, c chart, process capability analysis.	**08**
Quality assurance and acceptance control Objectives of acceptance control, hypothesis testing in acceptance control, average outgoing quality, lot-by-lot acceptance sampling by attributes, acceptance procedures based on AQL.	**08**
Total Quality Management Evolution of quality management, ISO standards, TQM approach, implementation of TQM, TQM critical success factors, Six Sigma implementation methodology.	**08**
Unit-II	
Reliability	**12**

Introduction, failure data, mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series configuration, parallel configuration, mixed configuration, reliability improvement.	
Maintainability Introduction, maintenance types- breakdown maintenance, shut down maintenance, corrective maintenance, preventive maintenance, predictive maintenance, productive maintenance, total productive maintenance, maintainability, availability, maintenance management, condition based management, Life Cycle costing.	**12**

Total = 48

Recommended Books

Title	*Author(s)*	*Publisher*
Industrial Maintenance Management	Sushil Kumar Srivastava	S Chand & Co.
Maintenance Engineering	Mishra	PHI
Reliability, Maintenance and Safety Engineering	A.K.Gupta	University Science Press
Reliability Engineering	L.S. Srinath	East-West Press

Subject Code : MET-612D
Title of the course : Weldability of engineering materials

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to

CO1: Understand the concept of weldablity.

CO2: Understand various problems related to weldability .

CO3: Learn basic principles and methods utilized for testing weldability.
CO4: Apply the knowledge ofweldability for various material alloy systems that are commonly used in commercial welding and manufacturing.
CO5: Apply theknowledge and skill for improvement of weldability for various materials .

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
Cos	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	3	3	1	3	1	1	1	3	3	3	2	1	1	1
CO2	2	3	2	1	2	1	1	2	2	2	3	2	1	1	2
CO3	2	3	3	1	3	1	2	1	2	2	3	2	1	2	1
CO4	2	3	3	3	3	1	1	1	2	2	3	2	1	1	1
CO5	2	3	3	1	3	1	2	1	2	2	3	3	1	2	1
Avera ge	2	3	2.8	1.4	2.8	1	1.4	1.2	2.2	2.2	3	2.2	1	1.4	1.2

Theory

Course Description	Lecture(s)
Unit-I	
Weldablity	**06**
Concept, factors effecting weldablity, weldablity tests, Hot and cold cracking tests.	
Weldablity of cast irons	**06**
Welding issues related to cast irons (Gray cast iron, white cast iron and malleable cast iron).	
Weldablity of carbon steels	**06**

Weldablity of low carbon steel, medium carbon steels and high carbon steels.	
Weldablity of stainless steels	**06**
Weldablity of austenitic, ferritic, martensitic stainless steels.	
Unit-II	
Weldablity of copper and its alloys	**06**
Weldablity factors, welding of copper and its alloys, brazing and soldering of copper and its alloys	
Weldablity of aluminium and its alloys	**06**
Welding of aluminium and its alloys (GTAW and GAW), problems associated with welding of aluminium.	
Weldablity of magnesium and nickel alloys	**08**
Welding of magnesium and nickel alloys, problem associated with welding of these alloys.	
Welding of plastics	**04**
Weldablity of engineering plastics, fabrication techniques.	

Total=48

Recommended Books

Title	***Author(s)***	***Publisher***
Welding Engineering & Technology	R. S. Parmar	Khanna Publications
Modern Arc Welding Technology	S. V. Nadkarni	Oxford & IBH.
AWS Welding Handbook, Volume-1	Leonard. P. Connor	AWS
Method of Testing Fusion Welded Joints and Weld Metals in Steel	IS-3600 (Part-I & II)	BIS, New Delhi
Welding Technology	O P Khanna	Dhanpat Rai

Subject Code : **MET-612E**
Title of the course : **Estimation and Costing**

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

The theory should be taught in such a manner that students are able to acquire different learning objectives in cognitive, psychomotor and affective domain to demonstrate following course outcomes.
CO1: Calculate material cost of given component/product.
CO2: Identify and estimate elements of cost in various processes.
CO3: Perform break even analysis to calculate break even quantity.
CO4: Investigate the problem of cost and suggest their solution using cost reduction techniques.
CO5: Prepare simple engineering contract.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3	3	3	1	1	1	2	2	3	3	3	1	1
CO2	3	3	3	3	3	1	2	1	2	2	2	3	1	3	1
CO3	3	3	3	3	3	1	1	2	2	2	2	3	2	2	2
CO4	3	3	3	3	3	1	1	1	2	2	2	3	2	2	2
CO5	3	3	3	3	3	1	1	3	2	2	2	3	2	2	3
Average	3	3	3	3	3	1	1.2	1.6	2	2	2.2	3	2	2	1.8

	Course Description	Lecture
Unit-I	**Introduction** Need, Scope & importance of Estimation, Costing & Contract in industries. Difference between costing and estimating. Terminology associated with various cost elements, overheads, their classification and allocation. Determination of selling price and catalogue price.	**06**
	Elements of costing Cost structure, Components of cost, overheads, types and methods of computing overheads, depreciation and obsolescence: Definition, types, different methods of calculating depreciation, numerical examples. Estimation of volume, weight and cost of materials for various products. Concept of Machine Hour Rate (MHR) and process hour rate (PHR). Method to calculate MHR for any machine/machine tool. (Lathe,	**10**

	Milling, Drilling, Grinding and Press tool). Method to calculate PHR for any process. PHR of running diesel generating set, welding and gas cutting. Estimation of Material cost.	
Unit-II	**Estimation in welding Shop** Factors effecting arc welding cost, Estimate cost of consumables and production for a given job using different welding methods.	**04**
	Estimation in other shops Estimation of cost of different products produced in machine shop (for various machining operations- turning, milling, drilling, boring, tapping, shaping, grinding, and planning). Foundry shop (Estimate cost of material, pattern and production for a casting component). Forging shops (Estimate cost of material, forging dies and production cost for a forging component). Understand importance of estimating various process costs. Identify the elements required to estimate the process cost.	**06**
	Budgeting and contracting Define budget and budgetary control. Purpose and benefits of budget. Various types of budgets. Interpret industrial budget. Prepare simple budget given required input data. Explain various accounting terminology like book value, Net Present Value, Work in progress, Gross Domestic Product (GDP), balance sheet terminology, etc. Introduction to different contracts, its characteristics and advantages. Tendering, manual tendering and E-tendering. Provision of different conditions in a contract. Documents required in an engineering contract.	**08**

Recommended Books		
Title	***Author(s)***	***Publisher***
	Text	
Mechanical Estimating and Costing	B P Sinha	Tata McGraw Hill, New Delhi
	Reference	
Mechanical estimating and Costing	TTTI, Madras	Tata McGraw Hill
Production Engineering, Estimating and Costing	M Adithan and B S Pabla	Konark Publishers, New Delhi
Mechanical estimating and costing	Banga and Sharma	Khanna Publishers
Mechanical costing and estimation	Singh & Khan	Khanna Publishers
Learning package in ECC	NITTTR, Bhopal	NITTTR, Bhopal

Subject Code : MET-613
Title of the course : Heat and Mass Transfer

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand fundamentals of different types of modes of Heat transfer.
CO2: Apply various mode of heat transfer to actual problems.
CO3: Understand various types of boiler.
CO4: Application of different type of Heat exchanger.
CO5: Understanding of Radiation and Mass-Transfer

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	2	2	2	2	2	2	2	2	2	1	1
CO2	2	3	3	3	2	2	2	2	2	2	3	2	2	3	1
CO3	2	2	2	3	2	2	2	2	3	2	2	2	1	3	2
CO4	2	3	2	2	2	2	2	2	2	2	2	2	2	1	2
CO5	3	3	3	2	2	2	3	2	3	2	2	3	1	1	1
Average	2.4	2.6	2.6	2.6	2	2	2.2	2	2.4	2	2.2	2.2	1.6	1.8	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Introduction	
Different modes of heat transfer: conduction, convection, radiation.	**6**
Conduction	
Fourier's law of heat conduction, thermal Conductivity, effect of temperature and pressure on thermal conductivity of solid, liquid. Three dimensional general conduction equations in rectangular cylindrical and spherical coordinates. Electrical analogy for solving 1-D steady state conduction problem for slab,	**6**

cylinder, sphere and influence of variable thermal Conductivity.	
Application of conduction	
Straight and circular fins of rectangular cross-section, optimum design of rectangular fin, efficiency of fin, fin effectiveness for rectangular and circular cross section fins. Application of fins in temperature measurement of flow In tubes. Critical radius of insulation for pipes and electrical cables. Introduction to unsteady state heat transfer.	**6**
Convection	
Free and forced convection, derivation, mass, momentum and energy equations. Concept of boundary layer, boundary layer thickness. Heat transfer coefficient. Heat transfer in laminar and turbulent flow over plates, tubes using empirical relations. Dimensional analysis for forced and free convection	**6**
Unit-2	
Boiling and Condensation	**6**
Introduction, boiling phenomena, pool boiling regimes, condensation drop-wise and film-wise.	
Heat Exchangers	
Overall coefficient of heat transfer, different design criterion of heat exchangers (LMTD & NTU methods), calculation of number, diameter & length of tubes, mean temperature difference for parallel & counter flow heat exchangers.	**6**
Radiation	
Laws of radiation, definition of- emissivity, absorbitivty, reflectivity and transmissivity. Concept of black and grey bodies Planck's law monochromatic radiation, Kirchoff's law and the geometric factor. Lambert's cosine law, definition of intensity of radiation, radiation exchange between simple bodies, two parallel surfaces, concentric cylinders, furnace walls, using definition of radiosity and irradiation, radiation shields, simple	**6**
Mass Transfer	
Mass transfer process : classification, Concentrations, velocities and fluxes, Fick's law, General equation of mass diffusion, Steady state diffusion through a plain membrane,Equimolal diffusion.	**6**

Total-48

Recommended Books

Title	***Author(s)***	***Publisher***
Heat and Mass Transfer	R. K. Rajput	S. Chand
Heat Transfer	J.P. Holman	TMH
Heat and Mass Transfer	R.C. Sachdeva	New Age International
Heat and Mass Transfer	R. Yadav	Central Publishing House
Heat Transfer	P.K.Nag	TMH
Heat Transfer	Domkundwar	Dhanpat Rai

Subject Code : MEP-613
Title of the course : Heat and Mass Transfer Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand fundamentals of different types of modes of Heat transfer.
CO2: Apply various mode of heat transfer to actual problems.
CO3: Understand various types of boiler.
CO4: Application of different type of Heat exchanger.
CO5: Understanding of Radiation and Mass-Transfer

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	2	2	2	2	2	2	2	2	2	1	1
CO2	2	3	3	3	2	2	2	2	2	2	3	2	2	3	1
CO3	2	2	2	3	2	2	2	2	3	2	2	2	1	3	2
CO4	2	3	2	2	2	2	2	2	2	2	2	2	2	1	2
CO5	3	3	3	2	2	2	3	2	3	2	2	3	1	1	1
Avera ge	2.4	2.6	2.6	2.6	2	2	2.2	2	2.4	2	2.2	2.2	1.6	1.8	1.4

LIST OF EXPERIMENTS

1. To determine the Thermal Conductivity of a Metal Bar.
2. To determine the total Thermal resistance and thermal conductivity or a composite wall.
3. To find out the convective heat transfer coefficient in a vertical cylinder in nature convection mode and also compare the results while using suitable empirical relation for the given configuration.
4. To find out heat transfer coefficient in forced convection mode and also compare the results while using suitable empirical relation for the given configuration. _
5. To find the thermal conductivity of insulating powder using sphere configuration.
6. To study the parallel & counter type heat exchanger & find out overall heat transfer coefficient and effectiveness of the heat exchanger for both parallel and counter type flow of heat exchanger.
7. To study the critical heat flux at various temp. or distilled water and, compare the result of critical heat flux at saturated condition with zubcr's co-relation.
8. To verify the Stefan Boltzmann constant help or the given experimental setup.
9. To find out the emissivity of the test plate at various surface temperatures

Subject Code : MET-616

Title of the course : Advanced Welding Processes

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals to solve welding problems.

CO2: Select a suitable welding process for a particular application.

CO3: Prepare a WPS for a particular application.

CO4: Understand the impact of welding operations on environment and need for sustainable development

CO5: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines

Pre-requisite knowledge: Conventional Welding Processes

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	1	1	1	2	2
CO2	3	3	2	3	2	1	3	2	2	1	3	1	1	1	1
CO3	2	2	2	2	3	1	3	2	2	2	2	2	1	1	2
CO4	2	2	2	3	3	1	3	2	2	2	2	2	1	2	1
CO5	2	2	2	2	3	1	3	2	2	2	2	3	1	1	1
Average	2.4	2.4	2.2	2.6	2.8	1.4	3	2.2	2.2	2	2	1.8	1	1.4	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Solid State Welding Processes	
Friction and friction stir welding, explosive welding, diffusion bonding, ultrasonic welding-Basic principle, process variables, weld characteristics and applications.	**08**
Thermit Welding	
Principle of operation, thermit mixtures, area of application.	**06**
Surfacing and Thermal Spraying	

Introduction to surfacing, type of surfacing (cladding, hard facing, built-up and buttering), different welding methods used for surfacing, different surfacing materials used and their characteristics, introduction to spraying, different spraying methods and applications.	**10**
Unit-II	
Electro Slag and Electro Gas Welding	
Principle of operation, equipment-power source, wire feeder and oscillator, guide tube consumable and non consumable, retaining shoes, welding head with control, travel carriage, process variation, advantages, disadvantages and applications, comparison between EGW and ESW.	**09**
Electron Beam Welding	
Principle of operation, equipment details, EBW in different degree of vacuum- high, medium and non vacuum, process characteristics (key hole penetration), process variables (acceleration voltage, beam power, spot size, travel speed, powder density), advantages, disadvantages and applications.	**09**
Laser Beam Welding	
Principle of operation, different laser medium (CO_2, Ruby and Nd-YAG), advantages, limitation and applications.	**06**

Total=48

Recommended Books:

1. Welding Processes and Technology by R.S Parmar (Publisher: Khanna Publishers)
2. Modern Arc Welding Technology by S.V. Nadkarni (Publisher: Oxford & IBH)
3. Modern Arc Welding Technology by Hobart B. Cary (Publisher; Prentice Hall Cambridge Univ. Press)

Subject Code : MEP-616

Title of the course : Advanced Welding Processes

L	T	P	Credits	Weekly Load
0	0	4	2	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Apply the knowledge of welding fundamentals to solve welding problems.
CO2: Select a suitable welding process for a particular application.
CO3: Prepare a WPS for a particular application.
CO4: Understand the impact of welding operations on environment and need for sustainable development
CO5: Apply the ethical principles regarding health, safety and legal issues during operations of welding machines

Pre-requisite knowledge: Conventional Welding Processes

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	1	1	1	2	2
CO2	3	3	2	3	2	1	3	2	2	1	3	1	1	1	1
CO3	2	2	2	2	3	1	3	2	2	2	2	2	1	1	2
CO4	2	2	2	3	3	1	3	2	2	2	2	2	1	2	1
CO5	2	2	2	2	3	1	3	2	2	2	2	3	1	1	1
Average	2.4	2.4	2.2	2.6	2.8	1.4	3	2.2	2.2	2	2	1.8	1	1.4	1.4

Experiment No	Name of Experiment
1.	To Learn the Safety and Precaution during the working on welding machine
2.	Demonstration and practice of resistance spot welding on zinc coated steel sheet
3.	To perform nugget test on specimen prepared by spot weld
4.	To perform flash butt welding on M.S round bar
5.	Demonstration and practice of underwater welding
6.	To join thin sheets by soldering using electrical operated soldering iron
7.	Demonstration and practice of friction welding
8.	Preparation of Lap joint by brazing
9.	Preparation and welding of lap joint by gas welding process

10.	**Hard facing on given job by MMAW**

Subject Code : MEO-621
Title of the course : CONCURRENT ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Should have basic knowledge of concurrent engineering for enhancement of product quality.

CO2: Should be able to apply the knowledge for design manufacturing assembly, quality function deployment, rapid prototyping and total design integration.

CO3: To apply concurrent technique for design inspection and testing for product design and development process.

CO4: To apply latest techniques resources engineering and IT tools for modeling and simulation of engineering systems

CO5: To demonstrate knowledge and understanding of concurrent engineering and management principle for integrating concurrent design and product development and consistent network

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2	2	1	1	1	2	1	2	1	1	1
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	2	1
CO4	3	3	2	3	3	2	3	2	3	1	2	1	2	2	2
CO5	3	3	3	3	3	3	3	3	3	1	3	3	1	1	1
Average	3	3	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Theory:

Course description	***Lectures***
UNIT-I	
Introduction Concurrent Engineering Definition, Product life cycle, quality products, evaporative markets, globalization and concurrent engineering	12

Concurrent Engineering Techniques Review of concurrent engineering techniques like DFM (design for manufacture). DFA (design for assembly), QFD (quality function deployment), RP (rapid prototyping), TD (total design) for integrating these technologies.	12
UNIT-II	
Product Design & Development Process Product information systems and their Mechanical Engineering architecture. Information environment for Suppliers, management, testing & inspection design engineering, purchasing, process control, manufacturing, support plans, operators, quality control, servicing and maintenance.	12

Product and Process Integration Product information modeling. Integration of information models and end users applications. Computer aided simultaneous engineering systems. Integrated concurrent design and product development. Constraint networks.	12

Recommended Books		
Title	***Author(s)***	***Publisher***
Integrated Product and Process Development	John M. Usher, Utpal Roy and H. R. Parasaei	Tata McGraw Hill
Product Design and Manufacture	A. K. Chitale and R. C. Gupta	PHI
Engineering Design and Design for Manufacturing: A structured approach	John R. Dixon and CorrodoPoli	Field Stone Publishers, USA
Material Selection in Mechanical Design	M. F. Ashby	Elsevier
Concurrent Engineering	Biren Prasad	Prentice Hall
Product Design & Development	Karl T. Ulrich, Steven D. Eppinger	TMHl

Subject Code : MEO-622
Title of the course : SYSTEM DYNAMICS AND CONTROL

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: Identify the Physical systems using Bond Graphs
CO2: Apply METLAB for simulation and dynamics.
CO3: Design and analysis of control system for linear and non-linear systems
CO4: Perform Stability analysis
CO5: Analyze dynamical system using bond graph.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	2	1	1	1	2	3	3	2	2	1
CO2	3	3	3	2	2	2	2	1	2	3	3	3	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	1
CO4	3	2	3	2	2	2	3	2	3	3	3	3	2	2	2
CO5	3	3	3	2	2	3	3	3	3	3	3	3	1	2	1
Average	3	2.8	3	2.2	2.2	2.4	2.2	2	2.4	2.8	3	3	1.6	1.8	1.4

Main Topics & Course Outline	**Lectures**
UNIT-I	
Introduction Introduction to Physical System Dynamics	12
Modeling of Physical System Dynamics: A Unified Approach Physical systems, Introduction to Bond graphs, Ports, Bonds and Power; Elements of Bond graphs:1-port elements : resistor R, Stiffness C, and Inertia I, Source of Effort Se and Flow SF; 2-port elements : Transformer TF and Gyrator GY, with modulation, Junction elements 1 and 0; Causality, Causality for basic 1-port and multi-ports. Derivation of System equations from Bond graphs in first order state space form.	
Bond Graph Modeling of Multi-energy Systems Mechanical Systems, Translation and rotation (about a fixed axis), Electrical Systems, Electromechanical Systems, Fluid systems, Transducer models–cylinder, rack and pinion, electromechanical transducers, pumps – positive displacement and centrifugal pump, gear	12

trains, etc.	
Analysis of Linear Systems Free & forced response for first and second order systems, Undamped& damped oscillator. Derivation of Signal flow graphs from Bond graphs. Derivation of Transfer functions.	
UNIT-II	
System Analysis Bode plots. State Variable Analysis. State transition matrix, Characteristic equation, Eigen values and Eigen vectors, Their impact on system response. Similarity transformations and their properties. Controllability and Observability, Canonical forms, Controllable, Observable, Diagonal.	12
Stability Criteria Routh-Hurwitz criterion	12
Controllers Proportional Integral and Derivative feedback	
Simulation Computer simulation of Dynamic Systems using Bond graphs	

Subject Code : MEO-623
Title of the course : Power Plant Engineering

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the present scenario of energy production in India and understand the different working aspects of hydro power plant

CO2: Explain the construction detail and the working of thermodynamic cycle of the thermal as well as gas power plant

CO3: To understand the power production techniques of nuclear power plant and to apply the knowledge for power plant economics for different load situations

CO4: Explore the knowledge in the field of non-conventional power generation methods and the direct energy conversion methods

CO5: Understand the pollution effects of power generation and ways to control them for the betterment of society

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	2	2	1	1	1	2	1	2	1	1	2
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	1	1
CO4	3	3	2	3	3	2	3	2	3	1	2	1	2	2	1
CO5	3	3	3	3	3	3	3	3	3	1	3	3	1	2	1
Avera ge	3	2.8	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Introduction Energy resources and their availability, Present power position and future planning in India & World, Types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.	**03**

HYDRO ELECTRIC POWER PLANTS Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, Advantages and comparison with other types of power plants.	**05**
STEAM POWER PLANTS Flow sheet and working of modern-thermal power plants, Classification of turbine, their working and governing, analysis of Re-heat cycle, Regenerative cycle, reheat –regenerative cycle and binary cycle Turbine problems, Condenser, Cooling ponds, cooling towers, Feed water treatment, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection mechanical dust collector and electrostatic precipitator.	**08**
GAS AND STEAM TURBINE COMBINED CYCLES Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems with organic fluids, parameters affecting thermodynamic efficiency and performance of combined cycles.	**08**
UNIT II	
NUCLEAR POWER PLANTS Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Gas-cooled reactors, liquid –metal cooled reactors, organic moderated cooled reactors, fast breeder reactor, Location of Nuclear power plants, Advantages and limitations, nuclear power station, Shielding Materials, Effect of nuclear radiation, waste disposal.	**07**
POWER PLANT ECONOMICS Load curve, different terminology and definitions, cost of electrical energy, tariff methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing.	**06**
NON-CONVENTIONAL POWER GENERATION Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.	**07**
DIRECT ENERGY CONVERSION SYSTEMS Fuel cell, MHD power generation-principle, open & closed cycle systems, thermoelectric power generation, and thermionic power generation	**02**
Pollution and its control Introduction, Air and water pollution by thermal power plants, Radioactive pollution of environment by nuclear power plants, Noise pollution, Methods for reducing the pollution.	**02**

Recommended Books:

1.Power Plant Engineering — P.K. Nag
2. Power Plant Engineering — P.C. Sharma
3. Power Plant Engineering — M. Wakil
4. Power Plant Engineering — ARORA.S.DOMKUNDWAR

Subject Code : PHT-621
Title of the course : Physics of Materials-Theory

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of the course, the students should be able to

CO1: Recognise common crystal structure and describe their symmetries.

CO2: Understand motion of electron in crystalline solids under periodic potential and able to differentiate materials on basis of band theory.

CO3: Describe nanomaterials based on their dimensionality.

CO4: To analysis the dielectric and magnetic properties of materials.

CO5: Understand the phenomenon of superconductivity and their properties in order to their applications.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	1	2	1	1	3	1	3	3	1	3
CO2	3	2	3	2	2	1	2	1	1	1	2	2	2	1	3
CO3	2	3	3	3	2	1	1	1	1	2	3	2	2	2	2
CO4	3	3	1	3	2	3	2	1	1	1	3	3	2	1	2
CO5	3	2	2	3	3	3	2	1	1	2	3	3	2	1	1
Average	2.8	2.6	2.2	2.8	2.2	1.8	1.8	1	1	1.8	2.4	2.6	2.2	1.2	2.2

UNIT-I

Elements of crystallography

A brief Introduction to material science Material structure, Space lattices, unit cell, primitive cell, Bravais lattice, Atomic packing factor, Miller indices, directions and planes in crystal lattice (cubic & hexagonal only), Distribution of atoms in lattice planes (in cubic crystal only), Important structures (NaCl, CsCl, diamond and ZnS), Structure determination: x-ray

diffraction,neuron and electron diffraction.

(08 Hrs)

Imperfections in crystals

Point imperfections, Frenkel and Schottky defects and their equilibrium concentration determination, Colourcentres, types of colourcentres, generation of colourcentres, Edge and screw dislocation, Berger vector, Surface and volume defects.

(5 Hrs)

Band theory of solids

Free electron theory, Concepts of energy bands, Bloch theorem, electron in a periodic field of crystal (the Kronig-Penny Model) and its applications in metal, Distinction between metal, semiconductor and insulator, Effective mass of an electron, Hall effect.

(6 Hrs)

Nano-materials

Fundamentals of nanomaterials and nanotechnology, Nano particles and Properties of nanomaterials, Synthesis, characterization & Applications of nanomaterials.

(5 Hrs)

UNIT-II

Dielectric materials

Introduction of dielectric materials, polarisation, Different types of polarization, electronic, ionic, orientational and space charge polarization, polarizability, Clausius-Mossotti relation, temperature and frequency dependence of polarizability, dielectric breakdown, measurement of dielectric properties, dielectric constant, dielectric loss, ferroelectric and piezoelectric materials examples of materials and their applications.

(8 Hrs.)

Magnetic Materials

Terminology and classification of magnetic materials, Types of magnetism (dia, para, ferro, ferri and antiferromagnetism), Theories of para, dia and ferromagnetic materials, Magnetic anisotropy and magnetostriction, magnetic domains, hard and soft magnetic materials, Ferrites and their applications.

(5 Hrs)

Superconductivity

Introduction, type I & type II superconductors, Meissner's effect and isotope effect, effects of magnetic field, London's equations and penetration depth, specific heat, BCS theory (electron-

lattice-electron interaction, cooper pair, coherence length and energy gap), High temperature superconductors, Applications of superconductivity.

(8 Hrs)

45 Hrs.

Recommended Books

Author	Title
Charles Kittel	Introduction to solid state Physics
MS Vijaya, G Rangarajan	Materials scienece
Raghvan	Materials science
Srinivasan and Srivastava	Materials science and Eng.
Callister JR	Materials science and Engg.: an introduction
Askeland and Phule	The science and engineering of material

Subject Code : PHP-621
Title of the course : Physics of Materials Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:
After successful completion of the course, the students should be able to

CO1: Differentiate between macro and microstructure in the materials.
CO2: Specify the microstructure of an alloy from phase diagrams
CO3: Understand type of charge carrier, mobility and carrier concentration and band gap of semiconductor.
CO4: Understand thermal and mechanical properties of material.
CO5: To analyze the electric, dielectric and magnetic properties and related phenomenon of materials

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	2	1	1	3	1	3	3	1	3
CO2	3	3	3	2	2	1	2	1	1	1	2	2	2	1	3
CO3	3	3	3	3	2	1	3	1	3	2	3	2	2	2	2
CO4	3	3	3	3	2	3	3	1	3	1	3	2	2	1	2
CO5	3	2	3	3	3	3	3	1	3	2	3	3	2	1	1
Average	3	2.8	3	2.8	2.2	1.8	2.6	1	2.2	1.8	2.4	2.4	2.2	1.2	2.2

List of Experiments

1. To prepare a metallic sample and measure the grain size using the metallurgical microscope.
2. To study the creep nature in metallic wires at room temperature.
3. To find the mobility and carrier concentration in a semiconductor sample using Hall Effect experiment.
4. To study the B-H curves of different materials.
5. To determine the Stefan's constant.
6. To determine the resistivity and energy band gap by four probe method
7. To find the Curie temperature of the given ferrite material.

8. To find the Curie temperature of the given ferroelectric material.
9. To calculate the dielectric constant of the given dielectric material.
10. To find the capacitance and permittivity of the given material.
11. To study the cooling curve and phase diagram of Pb-Sn alloy.

Subject Code : MET-621

Title of the course : CAD/CAM

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Enhance the knowledge of application of computers in designing.

CO2: Know about the hardware.

CO3: Designing and analysis ability in field of modeling the parts.

CO4: Understand the knowledge related to the use of computers in manufacturing.

CO5: Use CAD software to produce 2d and 3D designs.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2	1	1	1	2	3	3	2	2	2	1
CO2	3	2	2	2	2	2	1	2	3	3	3	1	3	2	2
CO3	2	1	3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	2	2	3	2	2	3	2	3	3	3	3	2	2	2	3
CO5	3	2	3	2	3	3	3	3	3	3	3	1	2	3	3
Average	2.6	1.8	2.4	2.2	2.4	2.2	2	2.4	2.8	3	3	1.6	2.2	2.4	2.4

Course Description	
UNIT-I	***Lectures***
Fundamentals of CAD/CAM	
Introduction to CAD and CAM. Definition of CAD and CAM tools. Applications of CAD/CAM. Design process and application of computers in design. Creating Manufacturing database. Benefits of CAD/CAM.	4
CAD Hardware	
Input devices: Keyboard, Touch panel, Light pens, Graphic tablets, Joysticks, Trackball, Mouse, Voice systems. Output devices: Storage, Tube graphics display, Raster refresh graphics display, Plasma panel displays, Liquid crystal displays. Central Processing Unit (CPU).	4
CAD Software and Database Management	

Graphic Standards: GKS, IGES, PHIGS. Data Structure and Database Management of a Graphics System. Coordinate Systems: WCS, MCS, SCS. Software modules: Operating System, Graphics, Application, Programming and Communication.	4
Curves, Surfaces and Solids	
Analytical curves: parametric and non-parametric equations; Bezier Curves; Introduction to free form curves: B-spline and NURBS; Surfaces: plane, cylindrical, spherical, ruled, coons patch, swept, revolved, Bezier, B-spline. Ferguson and Bilinear patch. Introduction to solid models; Solid representation, B-rep. CSG, Sweep representation; CAD/CAM data exchange.	7
Geometric Transformations	
Formulation, translation, rotation, scaling, reflection, mapping of geometric models, projections. Basic concepts of hidden surface removal and shading.	5
UNIT-II	
Fundamentals of Numerical Control	
Principles of NC, Types of NC machines, Classification of NC: Motion control, control loops, positioning systems, NC, CNC, DNC, Combined CNC/DNC systems.	5
NC Machines	
Constructional details of NC machines;Components of NC machines: MCU, drives, transducers, lead screw, control loops and interpolation, guide-ways. Tooling for NC machines: automatic tool changes, multiple pallets.	5
Numerical Control Programming	
Manual part programming; Block format and codes; Tool length and radius compensation; NC programming for cylindrical and prismatic components; Multiple axis NC machines; Tool path simulation of lathe and milling; Computer assisted part programming; post processor and auxiliary statements.	10
Adaptive Control Systems	
Types, advantages, adaptive control for proper cutting speed, feed in turning operation.	4
Total lectures	48
Recommended Books	

Title	***Author(s)***	***Publisher***
CAD/CAM – Theory and Practice	Zeid, Ibraham	Tata Mc Graw Hill
Geometric Modeling	Mortenson	John Wiley& Sons
Automation, Production Systems and CIM	Groover& Zimmer	PHI
Computer aided manufacturing	Chang, Wysk and Wang	PHI
Numerical Control and Computer Aided Manufacture	Kundra, Rao, Tiwari	Tata Mc Graw Hill

Subject Code : MEP-621
Title of the course : CAD/CAM Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Enhance the knowledge of application of computers in designing.
CO2: Know about the hardware.
CO3: Designing and analysis ability in field of modeling the parts.
CO4: Understand the knowledge related to the use of computers in manufacturing.
CO5: Use CAD software to produce 2d and 3D designs.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2	1	1	1	2	3	3	2	2	2	1
CO2	3	2	2	2	2	2	1	2	3	3	3	1	3	2	2
CO3	2	1	3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	2	2	3	2	2	3	2	3	3	3	3	2	2	2	3
CO5	3	2	3	2	3	3	3	3	3	3	3	1	2	3	3
Average	2.6	1.8	2.4	2.2	2.4	2.2	2	2.4	2.8	3	3	1.6	2.2	2.4	2.4

List of Experiments

S. No.	Title
1.	Introduction to AutoCAD and drawing and drafting of a 2D component
2.	Draw orthographic projections of given 2D components using AutoCAD
3.	Draw orthographic projection from given isometric views of given 3D components using AutoCAD
4.	Draw given isometric projections using AutoCAD
5.	Introduction to CNC Star Lathe and Part Programming for a given component using Fanuc controller
6.	Part Programming for a given component for CNC lathe using Fanuc controller, simulation and machining the component.
7.	Introductions to CNC Star Mill and Part programming for a given prismatic component using Fanuc controller
8.	Part programming for a given prismatic component using Fanuc controller, Simulation and

	machining the component.
9.	Make a program for transformations like scaling, rotation, translation etc. of Line/Rectangle/Triangle in C or MATLAB
10.	Make a program for drawing analytical or parametric curves like line, circle, parabola, hyperbola and Bezier.
11.	To make 3D model of the given component and generate its drawing using ProE/CATIA
12.	To make 3D model of given components and make assembly using ProE/CATIA

Subject Code : MET-623
Title of the course : Work Study and Ergonomics

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Critical examination of existing engineering methods.
CO2: Develop and improved method of any engineering operation/process/ system .
CO3: Identify the standard time for an operation/ activity.
CO4: Describe ergonomically designed engineering system.
CO5: Able to design & development of products/systems with applications of Ergonomics

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2	1	1	1	2	2	1	3	2	1	3
CO2	1	1	1	1	2	2	1	1	1	2	1	3	1	1	3
CO3	2	1	2	1	2	1	1	1	1	2	2	2	1	2	2
CO4	1	1	1	1	2	1	2	1	2	1	2	2	2	2	2
CO5	1	1	1	1	2	1	1	2	1	2	3	2	1	3	2
Average	1.2	1	1.2	1	2	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	2.4

Course Description	Lecture(s)
Unit-I	
Productivity	
Introduction, Types of productivity, Measurement of productivity, Productivity Index, Importance of productivity, Means of productivity improvement, Effect of productivity on society	**04**
Method Study	
Introduction to Work Study: Time study and method study, Objectives of work study, Method Study Procedure, factors for selection of Job for method study, Recording techniques: Charts, and Diagrams, Critical Examination, Principle of motion economy, Concept of Normal and maximum working area, Therbligs, Simo Chart, Micro motion study, Memo Motion Study, Cyclegraph and Chronocyclegraphs.	**16**
Unit-II	

Time Study	
Introduction to various work measurement techniques, Stop watch Time study: definition, equipments, Types of stop watches, stop watch time study procedure: Computation of number of cycles, types of work elements, guidelines for breaking the job into various work elements, Confidence levels and permissible error. Work sampling: definition, procedure, design of work sampling plans. PMTS: various methods, MTM-1, MTM-2, work factor Rating: Definition, Types of rating Techniques, Standard Performance, Normal Time, Observed Time and Standard Time, Uses of Standard Time, Allowances.	**16**
Ergonomics	
Definition, Components of Ergonomics: Anthropology, Physiology, Psychology and Machines, Design principles, Anthropometry: Definition, Structural Body Dimensions and Functional Body Dimensions, Seat Design, Design recommendations for seat design, Displays and controls: Types, design recommendations, design of control panels Environment: Light, ventilation, Vibration, Sound, House keeping	**12**

Total=48

Recommended Books:

1. NPC , A Manual of Method Study
2. ILO, Work Study
3. Dalela and Sharma, Work Study and Ergonomics, Standard
4. Barnes, Motion and Time Study, John Wiley

Subject Code : MEP-623
Title of the course : Work Study and Ergonomics Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Critical examination of existing engineering methods.

CO2: Develop and improved method of any engineering operation/process/ system .

CO3: Identify the standard time for an operation/ activity.

CO4: Describe ergonomically designed engineering system.

CO5: Able to design & development of products/systems with applications of Ergonomics

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2	1	1	1	2	2	1	3	2	1	3
CO2	1	1	1	1	2	2	1	1	1	2	1	3	1	1	3
CO3	2	1	2	1	2	1	1	1	1	2	2	2	1	2	2
CO4	1	1	1	1	2	1	2	1	2	1	2	2	2	2	2
CO5	1	1	1	1	2	1	1	2	1	2	3	2	1	3	2
Average	1.2	1	1.2	1	2	1.2	1.2	1.2	1.4	1.8	1.8	2.4	1.4	1.8	2.4

List of Experiments

1. Study and Construct Operation Process Chart of Given Activity
2. Study and Construct Flow Process Chart (Man Type) of Given Activity.
3. Study and Construct Two Handed Operation Chart of Given Activity.
4. Study design features of an Ergonomic Chair
5. Construct Charts for Minimum and Maximum working areas and Therbligs
6. To obtain performance rating for given activity (Playing cards).
7. To obtain performance rating for given activity (walking).
8. To compute standard time on Dexterity Ring Apparatus
9. To Design and perform work sampling plan to compute percentage utilization of any facility
10 To Construct string diagram for the given layout problem.

Subject Code : MET-624

Title of the course : Mechanical Design - I

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: apply the theories of failure in design of machine elements.

CO2: Application of theories of failure to thedesign a of various joints viz. riveted, welded, and screwed.

CO3: Analyse the temporary and permanent joints and design joints based on applications.

CO4: Apply the theories of static and dynamic failure theories to the design of Power screws, cotter joints, knuckle joints and shafts etc.

CO5: Select appropriate rolling contact bearing, gasket and seal from the standard catalogue based on loads.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	2	2	1	1	1	2	1	2	1	1	1
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	2	1
CO4	2	1	2	3	3	2	3	2	3	1	2	1	2	2	2
CO5	1	2	3	3	3	3	3	3	3	1	3	3	1	1	1
Average	2.4	2.4	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Theory

Course Description	**Lecture(s)**
Unit-I	
Introduction	
Introduction to design procedure, design requirements, review of force analysis concepts, factor of safety concepts, concept and mitigation of stress concentration, motor selection and mechanical Properties. General design considerations like fatigue, creep, fabrication methods, economic considerations, material selection and ergonomics.	**04**
Riveted and Welded Joints	
Type of riveted joints. Possible failure of riveted joints. Strength and efficiency of Butt (Single plate & double cover plate) and Lap riveted joints. Design of Boiler joints and	**07**

pressure vessels, Joint of Uniform strength. Common types of welded joints. Design for V-butt welded joints. Transverse fillet and parallel fillet welded joint. Axially and eccentrically loaded welded joint.	
Screwed Joints	
Introduction to term screw and various definitions of screw threads. Advantages and Disadvantages of screwed joints. Form of screw threads. Bolts of Uniform strength. Bolted joint for eccentric loading. Common types of screw fastening; through bolt, tap bolt, stud, cap screw, machine screw and set screw. Designation of screw threads. Stresses in screw fastening. Design of bolts for cylindrical cover	**07**
Power Screws	
Power to screw drive, efficiency of screw like square, trapezoidal threads, stresses in screw and design procedure of screw Jack. Condition for self locking.	**06**
Unit-II	
Cotter Joint and Knuckle Joint	
Design of cotter. Design of Socket. Design of Spigot. Design of knuckle joint; Design of rod. Design of Pin.	**07**
Shafts	
Design for static and dynamic loading; stresses in shaft, design of shaft subjected to bending moment or torsion moment and combined bending and torsion moments, shafts subjected to axial load in addition to combined bending and torsion moments failure theories; shafts subjected to fluctuating load conditions, cyclic loading, endurance limit, Soderberg Diagrams, fatigue strength and the S-N diagram, Design of shaft on the basis of rigidity.	**10**
Bearings	
Classification of bearing; Design, Specification and selection of Journal bearing, rolling contact bearing for given application.	**07**

Total=48

Recommended Books:

1. Shigley, J.E., and Mischke, C.R., "Mechanical Engineering Design (in S.I. Units)", 6th Ed., Tata McGraw-Hill, 2006.
2. Juvinall, R.C., and Marshek, K.M., "Fundamentals of Machine Component Design", 4th Ed., John Wiley & Sons, 2006.
3. Sharma & Aggarwal, "A Text book of Machine Design" , Katson.
4. Machine Design-An Integrated Approach, Norton, Pearson Education.
5. Mahadevan, K., and B., Reddy, "Design Data Hand Book", CBS Publishers, 2003.
6. P. S. G, "Design data handbook", P. S. G., Coimbatore.

Subject Code : MET-625

Title of the course: Metal Cutting and Forming

L	T	P	Credits	Weekly Load
2	0	0	2	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: understanding of basic concepts, chip formation mechanism, cutting forces and their impact on machining, optimization of machining operations.

CO2: awareness on different cutting tool materials, tool wear and wear mechanism of cutting tools, machinability and tool life principles.

CO3: Study the design considerations and development of lathe, drilling and milling dynamometers.

CO4: Understand the theory of plasticity and its application in metal forming operations to give insight to the students on theoretical and practical applications of metal forming operations.

CO5: to evaluate and analyze the stresses produced during rolling, wire drawing and strip drawing processes.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2	1	1	2	2	2	2	2	2	1
CO2	3	2	3	3	3	2	1	1	2	2	2	3	2	2	3
CO3	3	2	2	2	3	2	2	1	2	3	2	2	2	1	3
CO4	3	2	3	2	2	2	2	1	2	2	2	2	2	2	1
CO5	3	3	3	3	2	2	1	1	2	3	2	2	3	1	1
Average	3	2.4	2.6	2.6	2.6	2	1.4	1	2	2.4	2	2.2	2.2	1.6	1.8

Theory

Course Description	**Lecture(s)**
Unit-I	
Metal Machining	**04**
Kinematics, Elements involved in metal cutting action, classifications of cutting tools, Single point tools, multi point tools, principle angles on a single point cutting tool, tool signature, ASA system, ORS system, NRS system, Interrelation ship between ASA, ORS & NRS Systems. Concept of oblique cutting and orthogonal cutting	
Chip Formation Mechanism	**08**
Mechanics of chip formation, types of chips, adverse effect of BUE formation, Chip reduction coefficient, cutting ratio, shear plane, shear strain, chip velocity & velocity of shear, Factors involved in chip formation analysis, effect of cutting variables on chip reduction coefficient, Chip formation in Milling & drilling	
Force System in Machining	**08**
Force system during turning, Merchant circle diagram for cutting force, Frictional force system at chip tool interface, Force system at interface, Effect of obliquity, nose radius & wear land on force system, Forces in drilling & milling. Fundamentals of dynamometry, lathe dynamometer,	

drilling & milling dynamometer.	
Thermal Aspect in Machining	**03**
Heat generation in metal cutting, tool wear & temperature, coolants & their applications.	
Tool Wear	**03**
Types of tool wear, Machine ability, Tool life analysis & tool life equation.	
Unit-II	
Metal Forming: Plastic Deformation & Yield Criterion	**06**
Plasticity, True stress, True strain, Elastic & plastic strain, Yield stress, Plastic incompressibility, Poisson's ratio for plastic deformation, Von Misses yield criterion, Tresca yield criterion, generalized strain hardening curve	
Rolling	**04**
Analysis of the processes, Roll separating force, Torque on the rolls, Effect of front & back Tension, Effect of support rolls	
Wire & Strip Drawing	**06**
Analysis of the processes	
Plain Strain Forging	**06**
Analysis of the processes, Deep drawing of circular blanks-analysis of process, Extrusion-analysis of process.	

Total = 48

Recommended Books

	Title	*Author(s)*	*Publisher*
1.	Manufacturing Science	Malik & Ghosh	EWP
2.	Production Engineering Science	Pandey & Singh	Standard Publishers
3.	Metal cutting Theory	A.Bhattacharya	Central Book Publishers

Subject Code : MET-626

Title of the course : Welding Metallurgy

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Learn and understand about Iron-Carbon equilibrium diagram along with different phases as well as reactions found on this diagram.

CO2: Learn the concept of solidification of metals and alloys, epitaxial solidification. IDENTIFICATION OF Various zones of the weldment, weld zone, fusion boundary zone and HAZ

CO3: Calculate temperature at various locations

CO4: Develop welding procedures for different materials, UNDERSTAND about Welding of carbon steels, HSLA, Low alloy steels, Stainless steels and cast irons, Welding of dissimilar metals, Welding of plastics

CO5: Evaluate weldablity of different materials.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

Cos	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO4	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO5	2	2	3	3	3	2	2	2	1	1	2	3	2	1	1
Average	2	2	3	3	3	2	2	2	1	1	2	3	1.2	1.6	1

Course Description	Lecture(s)
Unit-I	
Introduction	
Introduction to Iron-Carbon equilibrium diagram, different phases, eutectic, eutectoid and peritectic reactions, lever rule, Overview of CCT and TTT diagrams.	**08**

Basic metallurgy of fusion welds	
Concept of solidification of metals and alloys, epitaxial solidification, Various zones of the weldment, weld zone, fusion boundary zone and HAZ (and its types), properties of HAZ, Microstructures formed in weldments, gas metal and slag metal reactions.	**08**
Heat flow in welding	
Temperature distribution in welding, Metallurgical effects of heat flow in welding	**04**
Preheat and postweld heat treatment	
Aims and methods of preheating and postweld heating, Preheating and PWHT of some specific steels	**04**
Unit-II	
Weldability of commonly used Engineering Materials Welding of carbon steels, HSLA, Low alloy steels, Stainless steels and cast irons, Welding of dissimilar metals, Welding of plastics.	**10**
Weld cracking	
Introduction and classification of weld cracks, factors affecting weld cracking, specific weld cracks	**04**
Weldability and weldability tests	
Introduction, Weldability assessment, Weldability tests, Fabrication weldability tests and basic service weldability tests	**10**

Total=48

Recommended Books:

1. Welding Metallurgy by Sindo Kou (Wileyinterscience)
2. Metallurgy of Welding J. F. Lancaster Allen &Unvin
3. The Metallurgy of Welding D. Seferian Chapman and Hall
4. Welding Engineering and technology by R.S. Parmar (Khanna Publications)
5. Welding Metallurgy (Volume-1) by George E.Linnert (AWS)
6. Modern Arc Welding Technology by S.V. Nadkarni (Oxford & IBH)

Subject Code : MEP-626

Title of the course : Welding Metallurgy Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Learn and understand about Iron-Carbon equilibrium diagram along with different phases as well as reactions found on this diagram.

CO2: Learn the concept of solidification of metals and alloys, epitaxial solidification. IDENTIFICATION OF Various zones of the weldment, weld zone, fusion boundary zone and HAZ

CO3: Calculate temperature at various locations

CO4: Develop welding procedures for different materials, UNDERSTAND about Welding of carbon steels, HSLA, Low alloy steels, Stainless steels and cast irons, Welding of dissimilar metals, Welding of plastics

CO5: Evaluate weldablity of different materials.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO4	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO5	2	2	3	3	3	2	2	2	1	1	2	3	2	1	1
Average	2	2	3	3	3	2	2	2	1	1	2	3	1.2	1.6	1

List of experiments

1. To study different zones of a weldment
2. To study various microstructural aspects of welded joints
3. To determine temperature distribution in welding
4. Concept of preheating and post heating in welding
5. Ferrite studies in welding of stainless steel
6. Study of weldability aspects of dissimilar welding

7. Studies on weld cracking
8. Weldability assessment of weldments
9. Study of various fabrication weldability tests

Subject Code : MEO-711
Title of the course : Properties and selection of engineering materials

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: The students will be able to display a critical awareness of the relevance of key areas, e.gmetals,alloys,properties of metals and defects in metals.

CO2: The students will be able to interpret mechanical properties, diffusion mechanism, dislocations and solidification of metals.

CO3: The students will also be able to interpret the applications of different materials used in modern industry and engineering.

CO4: The students will be able to understand composite material, polymers and smart materials and its applications.

Pre-requisite knowledge:

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):													Program Specific Outcomes (PSO)		
COs	Programme Outcomes (POs)												PSO 1	PSO 2	PSO 3
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	2	2	1
CO1	3	1	1	1	1	2	1	2	2	2	2	1	3	2	2
CO2	3	1	1	1	1	2	1	2	2	2	3	1	2	3	3
CO3	3	2	1	2	1	2	1	2	3	2	2	2	2	2	3
CO4	3	2	1	2	1	2	1	2	2	2	2	2	2	3	3
Avera ge	3	1.5	1	1.5	1	2	1	2	2.2 5	2	2.25	1.5	2.2	2.4	2.4

Unit	Course description	Lectures
	Unit 1	
1.	**Introduction:** Introduction to engineering materials, Industrial importance of common engineering materials-metals, non-metals and alloys, their properties (physical and mechanical) and applications.	4
2.	Metallic materials-Engineering Ferrous materials, Aluminium, Copper, Nickel, Magnesium, Titanium alloys. Phase diagrams, properties and typical alloys with reference to their applications.	8

3.	Mechanical properties of metals- Elastic deformation and plastic deformation, Interpretation of tensile stress-strain curves, Diffusion mechanisms and steady state and non-steady state diffusion, Dislocations and strengthening mechanisms, Nucleation of metals, Recrystallization and growth.	10
	Unit 2	
4.	Composite materials-Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials.	7
5.	Smart materials-Shape Memory Alloys, Intelligent materials for bio-medical applications, Polymers and Plastics from industry. Development, important properties and applications of these materials. Construction material:concrete materials, properties of concrete, reinforced and prestressedconcrete,asphalt, the structure of wood, moisture content and density of wood, mechanical properties of wood.	8
6.	Case study of the failure of components due to wrong selection of materials-Study and analysis of appropriate material for some specific application like aerospace, boiler tubes, turbine blades, automobiles and infrastructures (building and bridges). Economic environmental and social issues of material usage- environmental and societal considerations, recycling issues and life cycle analysis.	9

Recommended Books:

1. Materials and metallurgy by OP Khanna, Published by Dhanpat Rai.
2. Heat treatment principles and techniques by Rajan and Sharma, Published by PHI.
3. Introduction to physical metallurgy by Sidney H Avner, Published by TMH.
4. Materials Science & Engineering by William D. Callister, , Wiley India
5. The science and engineering of materials by Donald R. Askeland and pradeepP.Phule.

Subject Code : MEO-712
Title of the course : Robotics

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Develop the ability to analyze and design the motion for articulated systems.
CO2: Acquire the knowledge on advanced algebraic tools for the description of motion.
CO3: Understand the basic concepts of industrial robotics, namely in terms of classification, kinematics, sensors, and typical applications
CO4:Describe current status of robotics technology and new development
CO5: Understand the context and importance of robotics in the different society sectors.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2	1	1	2	2	3	1	2	1	1	2
CO2	3	2	2	1	1	1	2	3	2	3	1	1	1	2	3
CO3	3	3	2	1	1	1	1	3	3	3	2	2	1	1	3
CO4	3	2	2	1	1	1	2	2	2	3	2	1	1	2	2
CO5	3	1	2	1	1	1	2	3	2	3	1	1	1	2	3
Average	3	2	2	1	1.2	1	1.6	2.6	2.2	3	1.4	1.4	1	1.6	2.6

Course Description	Lecture(s)
Unit-I	
Introduction Evolution of robot and robotics, laws of robotics, robot anatomy: Links, joints, Degrees of freedom (DOF), Precision movement, robot specifications and work volume, Types of Robot drives-Basic robot motions, Arm configuration, wrist configuration.	**05**
End Effectors End effectors classification-Mechanical, magnetic, vacuum and adhesive gripper, Robot control-unit control system concept-servo and non servo control of robot joints, adaptive and optimal control.	**07**

Sensors Sensor devices Types of sensors- contact, position and displacement sensors, Force and torque sensors-proximity and range sensors-acoustic sensors- Robot vision systems, sensing and digitizing- Image processing and analysis.	**08**
Unit-II	
Coordinate Frame, Mapping and Transforms Coordinate frames, description of objects in space, transformation of vectors, fundamental rotation matrices**.**	**05**
Kinematics Denavit- Hartenberg Notation, kinematic relationship between adjacent links, Manipulator transformation matrix, Inverse kinematics, Concept of manipulator jacobian.	**09**
Robot Programming Robot language classification-programing methods off and on line programming, Lead through method, Teach pendent method, Language, simple program.	**08**
Industrial Applications Application of robots- Material handling- machine loading and unloading, Assembly, Inspection, Welding, spray painting, Recent developments ion robots-safety considerations.	**06**

Subject Code : MEO-713
Title of the course : Non conventional energy resources

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the operation of various non conventional energy resources.
CO2: Analyze the various non conventional energy resources.
CO3: Familiarize the components of non conventional energy resources.
CO4: Design of solar energy system and wind energy system.
CO5: Identify the application of various non conventional energy resources.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	2	2	1	1	1	2	1	2	1	1	2
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	1	1
CO4	3	3	2	3	3	2	3	2	3	1	2	1	2	2	1
CO5	3	3	3	3	3	3	3	3	3	1	3	3	1	2	1
Average	3	2.8	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Introduction	
Renewable and non-renewable energy sources, their availability and growth in India: energy consumption as a measure of Nations Development: strategy for meeting the future energy requirements.	(12 Hrs)
Solar Energy	
Solar radiations-beam and diffusion radiations; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces.	
Solar Energy Equipments	
Principles, introduction of different types of collectors, flat plate, cylindrical, and parabolic collectors; Solar energy storage system-their types, characteristics and capacity; solar ponds. Application of solar energy in water, space and process	(12 Hrs)

heating, solar refrigerant and air conditioning; water desalination and water pumping; Solar thermal power generation; solar cells and batteries.	
Wind Energy	
Principle of wind energy conservation; basic components of wind energy conversion systems; wind mill components, various types and their construction features; wind data and site selection considerations.	
Unit-II	
Direct Energy Conversion Systems	
i)Magnetic Thermodynamic(MHD) Generators; Operating principle, types and working of different MHD system-their relative merits; MHD materials and production of magnetic fields. ii) Thermo-Electric Generators; Thermo-electric effects and materials; thermoelectric devices and types of thermo-electric generators; thermo-electric refrigeration. iii) Thermionic Generators; Thermionic emission and materials; working principle of thermionic convertors. iv) Fuel Cell; Thermodynamic aspect; types, components and working of fuel cell. Performance, applications and economic aspects of above mentioned direct energy conversion systems.	(12Hrs)
Miscellaneous Non-Conventional Energy System	
i)Bio-Mass; Concept of bio-mass conversion, photo-synthesis and bio-gasification; bio gas generators and plants, their types constructional features and functioning; fuel properties of bio gas and community bio gas plants ii) Geothermal; Sources of geothermal energy types, constructional features and associated prime movers iii) Tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices, Advantages/disadvantages and applications of above mentioned energy system.	(12 Hrs)

Recommended Books;

Title	Author(s)	Publisher
Solar Energy: Fundamental And Application.	Jai Prakash, H.P. Garg	Tata McGraw-Hill.
Solar energy: Principles of Thermal collection & storage.	S.P. Sukhatme	Tata McGraw-Hill
Solar Engineering of Thermal Process.	Duffie Beckman	John WilleyDuffie
Energy conversion.	Chang	Publishers prentice Hall.

Title of the course : **Environmental Studies**

Subject Code : **CHM-711**

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Create an awareness about environmental problems among students
CO2	Impart basic knowledge about the environment and its allied problems.
CO3	Develop an attitude of concern for the environment.
CO4	Motivate public through students to participate in environment protection and environment improvement.
CO5	Acquiring skills to help the concerned individuals in identifying and solving environmental problems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	2	1	1	1	1	1	2	3	3	2	2	1	2	2
CO2	1	1	1	2	2	1	2	1	1	2	2	2	1	2	2
CO3	1	2	2	1	2	2	2	1	2	3	3	3	2	1	1
CO4	2	1	2	1	2	1	1	1	2	2	3	3	1	2	2
CO5	1	1	2	1	2	1	2	1	3	3	3	2	2	3	1
Average	1.2	1.4	1.6	1.2	1.8	1.2	1.6	1.2	2.2	2.6	2.6	2.4	1.4	2	1.6

Theory

Unit	Main Topics	Course outlines	Lecture(s)
Unit-1	Ecology and environment	Ecosystem; components, functioning, food chain and web, ecological pyramids. Biogeochemical cycles; water cycle, carbon cycle, nitrogen cycle. Biodiversity and its conservation.	08
	Sustainable development	Sustainable development; conflict between development and environmental conservation, international endeavors. Sustainable utilization of resources; energy resources, water resources, forest resources.	08
Unit-2	Environmental pollution	Water pollution; wastewater characterization, primary treatment, secondary biological treatment, general discharge standards. Air pollution; major pollutants, treatment devices, ambient standards. Solid waste management.	10
	Environmental Regulations	Green House Effect and Kyoto Protocol. Ozone layer depletion and Montreal Protocol. Environment Protection Act. Hazardous waste management.	06
			Total=32

Recommended Books:

1. E. Bharucha, Textbook for Environmental Studies; UGC Publication.
2. K.D. Wanger, Environmental Management; W.B. Saunders Publication.
3. E.P. Odum, Fundamentals of Ecology; W.B. Saunders Publication..
4. Pollution Control Acts, Rules and Notifications; CPCB Publication.

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HUT 711/722 PRINCIPLES OF MANAGEMENT

L	T	P	C
3	1	0	3.5

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand the concepts of management, administration and the evolution of management thoughts.

CO 2: Understand and apply the planning concepts.

CO 3: Analyze the different organizational structures and understand the staffing process.

CO 4: Analyze the various motivational and leadership theories and understand the communication and controlling processes.

CO 5: Understand the various international approaches to management

Pre-requisite:

1. Nil

CO/PO Mapping

(S/M/W indicates strength of corerelation) S-Strong,M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO :1											M	
CO :2											S	
CO :3											S	
CO :4									S	S		
CO :5											S	

Course Assessment methods:

Direct	Indirect
1. Minor –I 2. Minor – II 3. Quiz-1.Quiz-11 4.Assignment 5 End semester exam	**Course and Survey**

UNIT- I

MANAGEMENT CONCEPTS **9 Hrs**

Management – Definition – Importance – Functions – Skills required for managers - Roles andfunctions of managers – Science and Art of Management –Management and Administration.Evolution of Classical, Behavioral and Contemporary management thoughts.

PLANNING **9 Hrs**

Nature & Purpose – Steps involved in Planning – Forms of Planning – Types of plans – Plans at Individual, Department and Organization level - Managing by Objectives. Forecasting – Purpose
– Steps and techniques. Decision-making – Steps in decision making.

UNIT- II

ORGANISING

12 Hrs

Nature and Purpose of Organizing - Types of Business Organization - Formal and informal organization – Organization Chart – Structure and Process – Strategies of Departmentation– Line and Staff authority –Benefits and Limitations. Centralization Vs De-Centralization and Delegation of Authority. Staffing – Manpower Planning – Recruitment – Selection – Placement
– Induction.

UNIT- III

DIRECTING & CONTROLLING **10 Hrs**

Nature & Purpose – Manager Vs. Leader - Motivation - Theories and Techniques of Motivation.Leadership – Styles and theories of Leadership.Communication – Process – Types – Barriers – Improving effectiveness in Communication.
Controlling – Nature – Significance – Tools and Techniques.

UNIT- IV

CONTEMPORARY ISSUES IN MANAGEMENT **10 Hrs**

Corporate Governance Social responsibilities – Ethics in business – Recent issues.
American approach to Management, Japanese approach to Management, Chinese approach to Management and Indian approach to Management.

REFERENCES:

1. Tripathy PC And Reddy PN, "Principles of Management", Tata McGraw-Hill, 4th Edition, 2008.
2. Dinkar Pagare, "Principles of Management", Sultan Chand & Sons, 2000.
3. Kanagasapapathi. P "Indian Models of Economy, Business and Management", Prentice Hall of India, New Delhi, ISBN: 978-81-203-3423-6, 2008.
4. Vijayaraghavan, G.K.and Sivakumar, M. "Principles of Management", Lakshmi Publications, 5th Edition, 2009.
5. Harold Koontz & Heinz Weihrich, "Essentials of Management – An International perspective", 8th edition. Tata McGraw-Hill, 2009.
6. Charles W.L. Hill and Steven L McShane – Principles of Management, Tata Mc Graw-Hill, 2009.

Subject Code : MET-711
Title of the course : Metrology & Mechanical Measurements

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: KnowImportance of use of standard measurement practices in system analysis and quality control in a legal and ethical way.

CO2: Understanding of basic principle of sensing in measurement of physical quantities and automation of instruments.

CO3: Understanding of basics of micron and submicron level measurements by mechanical and optical methods and latest development in such measurements.

CO4: **U**se and develop sustainable measurement systems for shop floor.

CO5: Handle various measuring instruments

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1	1	1	2	1	1	1	2	2	1
CO2	3	3	3	3	3	1	1	1	2	2	1	1	1	2	1
CO3	3	3	3	3	3	1	2	1	2	1	1	1	1	2	2
CO4	3	3	3	3	3	1	1	1	2	1	2	1	2	1	2
Average	3	3	3	3	3	1	1.25	1	2	1.25	1.25	1	1.5	1.75	1.5

Theory

Course Description	Lecture(s)
Unit-I	
Introduction	
Measurement, definition, aim, method of measurement, measurements in design, factor in selection of measuring instruments, measurements systems, time element in measurement, error in measuring instruments, temperature problem, static & dynamic characteristics of measuring instruments, calibration, error, classification, system error analysis, theoretical relationships.	07
Standard of Measurements	
Introduction, legal status, present measurement system & its advantage over previous system, standard of length, mass, time, temp. etc.	05
Displacement & Dimensional Measurement	

Problems of dimensional measurement, gage block, surface plate, temp problem etc., use of different type of comparators, optical method, optical flats, application of monochromatic light & optical flats, use of optical flats & monochromatic light for dimensional comparison, interferometer.	07
Surface Testing & Measurement	
Surface roughness, definition, various methods to measure surface roughness, different instruments for measuring surface roughness, roughness standard.	05
Unit-II	
Speed Measurement	
Introduction, use of counters, stroboscope, direct application of frequency standard by comparative methods, calibration of frequency sources, tachometers, different types- mechanical, electrical, frequency tachometer.	06
Stress Strain Measurements & Strain Graphs	
Introduction, mechanical strain gauges, optical strain gauges, electrical strain gauges, stress measurement by variable resistance strain gauge, sensing element materials, forms of strain gauge sensing elements, strain gauge adhesive, protective coating, strain gauge mounting techniques.	06
Measurement of Force & Torque	
Introduction, measuring methods, elastic transducers, strain gauge, load cell, piezo type load cell, hydraulic & pneumatic system, torque measurement, dynamometer, classification, type & characteristics.	06
Screw Thread Measurements	
Errors in threads, screw thread gauges, measurement of elements of the external & internal threads using caliper gauges, various other methods to measure screw thread parameters	03
Spur Gear Measurement	
Geometry of spur gear, measurement of spur gear parameters, run out, pitch, profile, lead, backlash, tooth thickness, composite elements, various other methods to measure spur gear parameters.	03

Total=48

Recommended Books:

1. Nakra& Chaudhary, Instrumentation, Measurement & Analysis; Tata McGraw Hill
2. E. O. Doebelin, Measurement Systems, Application & Design; Tata McGraw Hill
3. J.W. Dally, R.F. William and Mc Connell, Instrumentation for Engg. Measurement; John Wiley and Sons
4. K.J. Aume, Metrology & Interchangeability; McDonald and Company Ltd.
5. T. G. Beckwith, L.N. Buck and R. D. Marangoi, Mechanical Measurements; Addison Wesley Reading

Subject Code : MEP-711
Title of the course : Metrology & Mechanical Measurements Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Know Importance of use of standard measurement practices in system analysis and quality control in a legal and ethical way.

CO2: Understanding of basic principle of sensing in measurement of physical quantities and automation of instruments.

CO3: Understanding of basics of micron and submicron level measurements by mechanical and optical methods and latest development in such measurements.

CO4: Use and develop sustainable measurement systems for shop floor.

CO5: Handle various measuring instruments

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	1	1	2	1	1	1	2	2	1
CO2	3	3	3	3	3	1	1	1	2	2	1	1	1	2	1
CO3	3	3	3	3	3	1	2	1	2	1	1	1	1	2	2
CO4	3	3	3	3	3	1	1	1	2	1	2	1	2	1	2
Average	3	3	3	3	3	1	1.25	1	2	1.25	1.25	1	1.5	1.75	1.5

List of Experiments

1. Linear measurement of the test samples by
   a) Vernier caliper, b) Micrometer, c) Vernier depth gauge and d) height gauge
2. Study and measurements using telescopic gauge and bore gauge
3. Study and measurement using dial test indicator
4. Study and measurements using profile projector
5. Study and measurements using tool room microscope
6. Angle measurement of test sample using sine bar
7. Study and measurement using electronic comparator
8. Speed measurement of shaft by stroboscope and tachometer
9. Measurement of surface roughness by SURFCODER

10. Calibration of dial gauge by dial calibration tester
11. Calibrate of pressure gauges with dead weight calibrator
12. Calibration of verniercaliper and micrometer

Subject Code : MET-715
Title of the course : Welding codes and standards

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Generate ethical values by knowing about welding codes and standards

CO2: **P**repare WPS and PQR for Industrial welding applications

CO3: Acquire knowledge about industrial materials, welding consumables and their applications

CO4: Prepare WPS for pipeline for petroleum applications

CO5: Understand basic testing methods for weld qualification.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2	1	1	1	2	3	3	2	2	2	1
CO2	3	2	2	2	2	2	1	2	3	3	3	1	3	2	2
CO3	2	1	3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	2	2	3	2	2	3	2	3	3	3	3	2	2	2	3
CO5	3	2	3	2	3	3	3	3	3	3	3	1	2	3	3
Average	2.6	1.8	2.4	2.2	2.4	2.2	2	2.4	2.8	3	3	1.6	2.2	2.4	2.4

Course Description	**Lecture(s)**
Unit -1	
Weld Joints and welding symbols	
Types of weld joints, Types of welds, Essential elements of a basic welding symbol, Primary and secondary weld symbols, various information and location of this information on welding symbol.	08
Base materials and consumables	
Introduction to ASME section II part A and C; introduction to base materials and consumables standards, consumables testing and qualification as per ASME/AWS requirements.	08
Pressure vessel fabrication	
Introduction to ASME section VIII- division I, fabrication methods, joint categories, welding and inspection requirements, post weld heat treatment and hydro-testing.	08
Unit-II	
Welding procedure specifications (WPS)	

Introduction to ASME section IX; introduction to Welding Procedure Specification (WPS)-essential, non-essential and supplementary essential variables, procedure qualification, Procedure Qualification Records (PQR); welders performance qualification, welder and welding operator	08
Indian Boiler Regulations (IBR)	
Introduction to IBR-1950, workmanship for fabrication of shell type welded boilers, qualification and requalification of welders to be engaged for welding of boilers.	08
Cross Country Pipe line Welding	
Introduction to API 5L welding code, Process and product standards for manufacturing of pipes , welding procedure and welder qualification, field welding and inspection requirements.	08

Total: 48

Books Recommended:

1. Indian Boiler Regulations-1950
2. API 5L
3. ASME Section VIII - Division 1
4. ASME Section IX
5. ASME Section II Part A and Part C

Subject Code : MET-716
Title of the course : Inspection and Testing of Weldments

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **I**dentifying various weld defects and understand the nature of occurrence of these defects along with their remedial measures.

CO2: Understand the meaning of welding inspection, responsibilities in welding inspection, role and certification of welding inspectors.

CO3: Develop a WPS for particular application

CO4: Learn about various destructive and non-destructive techniques used in welding.

CO5: Apply about Statistical Quality Control Techniques for testing of welds.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2	2	1	1	1	2	1	2	1	1	1
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	2	1
CO4	3	3	2	3	3	2	3	2	3	1	2	1	2	2	2
CO5	3	3	3	3	3	3	3	3	3	1	3	3	1	1	1
Average	3	3	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Theory

Course Description	**Lecture(s)**
Unit-I	
Weld Discontinuities and Quality Assurance:	**12**
Definition of discontinuity, imperfection and defects, classification of various welding defects, causes and remedies. Concept of quality assurance in welding, weld quality-meaning, organization, requirement, procedure and program for quality assurance.	
Welding Inspection and Welding Procedure Specification (WPS):	**08**
Meaning of welding inspection, responsibilities in welding inspection, role and	

certification of welding inspectors. Description and important details of WPS; Essential, non-essential and supplementary variables, various steps in procedure qualification, PQR (procedure qualification record).	
Qualification of Welders and Welding Operators:	**04**
Welding performance qualification-requirement, qualification and re-qualification of welders, Qualification record, Essential and non-essential variables in performance qualification.	
UNIT-II	
Destructive Testing of Welds:	**12**
Classification and description of destructive testing techniques like Tensile test, Bend test, Impact test, Hardness test, Fatigue test; Testing of welding consumables-All weld test, Determination of diffusible hydrogen, Deposition efficiency, Coating moisture determination.	
Non Destructive Testing:	**08**
Visual inspection, dye-penetrate inspection, magnetic particle inspection, ultrasonic testing, radiographic testing, eddy current testing.	
Statistical Quality Control Techniques applied to Weld Testing:	**04**
Basic concept about application of control charts and acceptance sampling for testing and inspection of welds	

Total=48

Recommended Books

Title	***Author(s)***	***Publisher***
Welding Engineering & Technology	R. S. Parmar	Khanna Publications
Modern Arc Welding Technology	S. V. Nadkarni	Oxford & IBH.
AWS Welding Handbook, Volume-1	Leonard. P. Connor	AWS
Statistical Quality Control	Juran	McGraw Hill.
Quality Control	Mahajan	Dhanpat Rai & Sons
Method of Testing Fusion Welded Joints and Weld Metals in Steel	IS-3600 (Part-I & II)	BIS, New Delhi
ASME Boiler and Pressure Vessel Code Section IX.		ASME
Welding Technology	O P Khanna	Dhanpat Rai

Subject Code : MEP-716
Title of the course : Inspection and Testing of Weldments Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: **I**dentifying various weld defects and understand the nature of occurrence of these defects along with their remedial measures.

CO2: Understand the meaning of welding inspection, responsibilities in welding inspection, role and certification of welding inspectors.

CO3: Develop a WPS for particular application

CO4: Learn about various destructive and non-destructive techniques used in welding.

CO5: Apply about Statistical Quality Control Techniques for testing of welds.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	2	2	1	1	1	2	1	2	1	1	1
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	2	1
CO4	3	3	2	3	3	2	3	2	3	1	2	1	2	2	2
CO5	3	3	3	3	3	3	3	3	3	1	3	3	1	1	1
Average	3	3	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

List of experiments:

1. Introduction to destructive testing facilities in the lab.
2. Introduction to non-destructive testing facilities in the lab.
3. Demonstration for the working of muffle furnace.
4. Study and demonstration of tensile test.
5. Study and demonstration of compressive test.
6. Study and demonstration of impact strength (Charpy V-notch) test.
7. Study and demonstration of impact strength (Izod) test.
8. Study and demonstration of U-bend test.
9. To perform visual inspection of a given weld specimen.
10. To perform magnetic particle inspection of a given weld specimen.

11. To perform die penetrant test on a given weld specimen
12. To perform ultrasonic test on a given weld specimen
13. Hardness test.

Subject Code : MEO-721

Title of the course : Finite Element Methods

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Explain strain-displacement and stress-strain relations with and without the temperature effect.

CO2: Explain various numerical methods which can be applied to mechanical problems.

CO3: Discretize the continuum domain into finite element mesh using various types of elements.

CO4: Apply the finite element methods and analyze the implementation to solve static, scalar field and dynamic problems.

CO5: Formulate the computer implementation of the finite element methods.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	1	1	2	3	3	2	2	1
CO2	3	3	3	2	2	2	2	1	2	3	3	3	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	1
CO4	3	2	3	2	2	2	3	2	3	3	3	3	2	2	2
CO5	3	3	3	2	2	3	3	3	3	3	3	3	1	2	1
Average	3	2.8	3	2.2	2.2	2.4	2.2	2	2.4	2.8	3	3	1.6	1.8	1.4

Course Description	**Lectures**
Unit-I	
Introduction	
Historical Background, Stresses and equilibrium, Boundary Conditions, Strain-Displacement Relations, Stress-Strain Relations, Temperature Effects, Vectors and Matrices.	**06**
Introduction & Fundamental Concepts	
Rayleigh-Ritz Method, Galerkin's Method, Point Collocation Method, Least Square Method, Weighted Residual Method.	**06**
1-D FE Modeling	

Finite Element Modeling, Coordinates and Shape Functions, The Potential Energy Approach, The Galerkin's Approach, Assembly of Global Stiffness matrix and Load vector, Properties of Stiffness Matrix, Treatment of Boundary Conditions and Temperature Effects.	**08**
2-D FE Modeling	
Finite Element Modeling, Constant Strain Triangle (CST).	**04**
Unit-II	
2-D FE Modeling	
The Four Node Quadrilateral, Numerical Integration, Higher Order Elements; Nine Node Quadrilateral, Eight Node Quadrilaterals, Six Node Triangle.	**05**
Truss	
Introduction, Plane Trusses, Assembly of Global Stiffness Matrix and Load Vector. (For 1D and 2D problems only)	**08**
Scalar Field Problems	
Introduction, Steady-state heat transfer, Potential Flow, Fluid Flow in ducts.	**04**
Dynamic Considerations	
Element Mass Matrices, Evaluation of Eigen Values and Eigen Vectors. (Introduction only)	**04**
Computer Implementation	
Introduction; Computer Program Organization for Calculation of System Matrices.	**03**

Subject Code : MEO-722
Title of the course : Design of Experiments

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: Understand the basic concepts of optimization.
CO2: Understand the basic concepts of experimentation analysis
CO3: Develop mathematical model for random phenomena.
CO4: Develop engineering solutions based on statistical analysis.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2	1	1	1	2	3	3	2	2	2	1
CO2	3	2	2	2	2	2	1	2	3	3	3	1	3	2	2
CO3	2	1	3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	2	2	3	2	2	3	2	3	3	3	3	2	2	2	3
CO5	3	2	3	2	3	3	3	3	3	3	3	1	2	3	3
Average	2.6	1.8	2.4	2.2	2.4	2.2	2	2.4	2.8	3	3	1.6	2.2	2.4	2.4

Theory

Course Description	Lecture(s)
Unit-I	
Introduction Introduction to optimization techniques & types, strategy of experimentation, procedure to design the experimentation.	**04**
Collection of data Introduction, primary & secondary data, graphical representation of data, bar chart, histograms, dot plot, scatter plot & box-whiskor plot, sampling & sampling distribution, acceptance sampling; single, double & multiple sampling plan,	**08**

Data analysis Measures of central tendency; arithmetic mean, median, mode, measures of dispersion, range, deviation, variance, correlation, types of correlation, normal distribution.	**10**
Unit-II	
Regression analysis Introduction, uses of regression analysis, difference between correlation and regression analysis, regression line and equations; regression equation of Y on X & regression equation of X on Y, standard error of estimate.	**08**
Analysis of variance Introduction, assumption, techniques of analysis of variance; one way ANOVA, two ways ANOVA, numerical on ANOVA.	**08**
Hypo thesis testing Definition, degree of freedom, hypotheses testing, critical region, level of significance, errors in sampling, test of significance for small samples & large samples, T - test, Z – test	**10**

Recommended Books:

Title	*Author(s*	*Publisher*
Design & analysis of experiments,	Douglas C Montgomery	John Wiley
Statistical design and analysis of experiment	John. P. W. M.	John Wiley
Statistical methods for engineering & science	HC Taneja,	I.K. international pub. House
Statistical methods	SP Gupta	Sultan Chand & son’s

Subject Code : MET-721
Title of the course : AUTOMOBILE ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the basic knowledge of automobile component, different systems and its performance.

CO2: Assess the basics about Automotive Engine System and fuel supply System and apply to different type of vehicles.

CO3: Understand the concept of Automobile Chassis, hydraulically operated clutch, fly wheel, and automotive brake system.

CO4: Understand about Automotive Transmission, types of gear, working of gear boxand apply the knowledge to Gear selector mechanism, differentials and drive axles.

CO5: Learn the basic concepts of Automotive Electronic and Electrical Equipment and application to various parts of automobile

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1	1	1	2	2	3	3	3	1	1
CO2	3	3	3	3	3	1	2	1	2	2	2	3	1	3	1
CO3	3	3	3	3	3	1	1	2	2	2	2	3	2	2	2
CO4	3	3	3	3	3	1	1	1	2	2	2	3	2	2	2
CO5	3	3	3	3	3	1	1	3	2	2	2	3	2	2	3
Average	3	3	3	3	3	1	1.2	1.6	2	2	2.2	3	2	2	1.8

Theory

Unit	Main Topic	Course out line	Lectures
Unit-I			
	1. Engine fundamentals and performance.	Introduction-Engine fundamentals, engine operations, engine type and construction. Engine measurement and performance.	**6**

	2.Automobile Engine Components:	Automobile Engine Components: connecting rods, rod bearings, piston rings, crank shaft, cylinder blocks, valves & valves train,	**6**
	3.Engine fuel supply System	Automotive engine fuels, fuel and exhaust system, carburetors, carburetor fuel system service, diesel fuel engines injection system, gasoline fuel injection system.	**6**
	4. Automotive Engine System	Engine lubricating system, engine cooling systems, emission control & tune up. .	**6**
Units-II	**5.Automotive Chassis**	Automotive Chassis:Spring and suspension system, steering systems, automobile clutches, hydraulically operated clutch, pressure plate, fly wheel, adjusting wheel, spacing, and automotive brake system.	**8**
	6.Automotive Transmission:	Automotive Transmission:Gear ratio, types of gear, types of gear box, working of gear box, Gear selector mechanism, planetary type gear box, universal joints, and differentials and drive axles.	**8**
	7.Automotive Electronic and Electrical Equipment:	Automotive Electronic and Electrical Equipment:The automotive electrical system, starting system, central point ignition, electronic ignition system, automotive battery.	**8**

Total-48

Recommended Books:

Title	**Authors**	**Publishers**
1.Automobile Engineering	Nakre	Standard
2. Automobile Mechanics	Crouse	Tata McGraw Hill
3. Automobile Engineering	Kirpal Singh	Standard
4. A Tex Book of IC Engine	Mathur& Sharma	Dhanpat Rai

Subject Code : MEP-721
Title of the course : AUTOMOBILE ENGINEERING

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the basic knowledge of automobile component, different systems and its performance.

CO2: Assess the basics about Automotive Engine System and fuel supply System and apply to different type of vehicles.

CO3: Understand the concept of Automobile Chassis, hydraulically operated clutch, fly wheel, and automotive brake system.

CO4: Understand about Automotive Transmission, types of gear, working of gear boxand apply the knowledge to Gear selector mechanism, differentials and drive axles.

CO5: Learn the basic concepts of Automotive Electronic and Electrical Equipment and application to various parts of automobile

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1	1	1	2	2	3	3	3	1	1
CO2	3	3	3	3	3	1	2	1	2	2	2	3	1	3	1
CO3	3	3	3	3	3	1	1	2	2	2	2	3	2	2	2
CO4	3	3	3	3	3	1	1	1	2	2	2	3	2	2	2
CO5	3	3	3	3	3	1	1	3	2	2	2	3	2	2	3
Average	3	3	3	3	3	1	1.2	1.6	2	2	2.2	3	2	2	1.8

List of Experiments

1. Construction Details and working of 4-stroke and 2-stroke petrol engine.
2. Construction Details and working of engine components in 4-stroke Diesel engine.
3. Construction Details and working of fuel supply system in petrol engine.
4. Construction Details and working of ignition system in petrol engine.
5. Construction Details and working of fuel supply system in diesel engine.
6. Construction Details and working of clutch and its various components.
7. Construction Details and working of gear box and its components.
8. Construction Details and working of differential.

9. Construction Details and working of brakes in automobile.
10. Construction Details and working of steering system of a car.
11. Construction Details and working of suspension system of an automobile.

Title of the course : Human values and professional ethics

Subject Code : HUM-721

L	T	P	Credits	Weekly Load
2	0	0	2	2

CO1: Students will understand the importance of Values and Ethics in their Personal lives and professional careers

CO2: The students will learn the rights and responsibilities

CO3: Responsibilities of employee, team member and a global citizen.

CO4: Apply practical strategies for handling ethical dilemmas.

CO5: Understand the importance of communication and ethics with all stakeholders.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	1	1	1	2	3	2	3	3	1	2	2	1	2	1
CO2	1	1	1	1	2	3	2	2	2	1	2	1	1	1	1
CO3	2	1	1	1	2	1	2	1	2	1	2	1	1	2	1
CO4	2	1	1	2	1	2	3	2	1	2	1	1	2	1	1
CO5	1	1	1	1	2	3	2	2	2	1	2	1	1	1	1
Average	1.4	1	1	1.2	1.8	2.4	2.2	2	2	1.2	1.8	1.2	1.2	1.4	1

Course Description	**Lecture(s)**
Unit-I	
Values and Self Development	
Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non moral valuation, Standards and principles, Value judgments. Importance of cultivation	04

of values, Sense of duty, Devotion, Self reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National unity, Patriotism, Love for nature, Discipline.	
Personality and Behavior Development	
Soul and scientific attitude, God and scientific attitude, Positive thinking, Integrity and discipline, Punctuality, Love and kindness, Avoiding fault finding, Free from anger, Dignity of labor, Universal brotherhood and religious tolerance, True friendship, Happiness vs. suffering love for truth, Aware of self destructive habits, Association and cooperation, Doing best, Saving nature.	04
Unit-II	
Character and Competence	
Science vs. God, Holy books vs. blind faith, Self management and good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of women, All religions and same message, Mind your mind, Self control, Honesty, Studying effectively.	03
Human Rights	
Jurisprudence of human rights nature and definition, Universal protection of human rights, Regional protection of human rights, National level protection of human rights, Human rights and vulnerable groups.	02
Competence in professional ethics	
Ability to utilize the professional competence for augmenting universal human order, Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems	03

Total=16

Recommended Books:

1) S.K.Chakraborty, Values and Ethics for Organizations Theory and Practice; Oxford University Press, New Delhi,2001.

2) S.K. Kapoor, Human rights under International Law and Indian Law; Prentice Hall of India, New Delhi, 2002.

3) D.D. Basu, Indian Constitution; Oxford University Press, New Delhi, 2002.

4) W.K. Frankena, Ethics; Prentice Hall of India, New Delhi, 1990.

5) R. R. Gaur, R. Sangal, G. P. Bagaria, A Foundation Course in Value Education. 2009,

6) M Govindrajran, S Natrajan, V.S. Senthil Kumar, Engineering Ethics(including Human Values); Eastern Economy Edition, Prentice Hall of India Ltd.

Subject Code : MET-722
Title of the course : Operations Research

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understand the basic concepts & issues of engineering optimization and application of optimization techniques.

CO2: Formulate the linear programming problem using different approaches and attempt the variations of the class of problems.

CO3: Device assignment model, and attempt the variations of the class of problems.

CO4: Draw the network diagrams for project management.

CO5: Understand the basic concepts of queuing theory and analyze the case studies based on (M/M/1) model.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	1	1	1	2	2
CO2	3	3	2	3	2	1	3	2	2	1	3	1	1	1	1
CO3	2	2	2	2	3	1	3	2	2	2	2	2	1	1	2
CO4	2	2	2	3	3	1	3	2	2	2	2	2	1	2	1
CO5	2	2	2	2	3	1	3	2	2	2	2	3	1	1	1
Average	2.4	2.4	2.2	2.6	2.8	1.4	3	2.2	2.2	2	2	1.8	1	1.4	1.4

Theory

Course Description	Lecture(s)
Unit-I	
Introduction	**04**
Meaning of OR, historical development, characteristics of OR, application of OR, main feature of	

OR, scope of OR, Classification of optimization techniques in brief.	
Linear Programming	**10**
Introduction, formulation of LP problem, graphical representation and solution to LP problems, simplex method, two phase method, degeneracy problem, Big-M method, duality in linear programming.	
Transportation Model	**10**
Definition, mathematical formulation, optimal solution of transportation problem, optimality test, balanced and unbalanced problem, minimization and maximization problem, different methods of finding solution.	
Unit-II	
Assignment Model	**08**
Introduction, mathematical formulation, Hungarian method for assignment problem, minimization and maximization problem, unbalanced, sequencing and traveling salesman problems.	
NETWORK ANALYSIS IN PROJECT PLANNING (PERT & CPM)	**10**
Introduction, evolution and application of PERT & CPM technique, Drawing of network diagram, float and slack times, time estimates, critical path, crashing and updating problem.	
Queuing Model	**06**
Introduction, elements/structure, operating characteristics, classification of Queuing model, Kendall's Notation for representing Queuing Model, Case studies on (M/M/I) Model.	

Total=48

Recommended Books:

	Title	*Author(s)*	*Publisher*
1.	Engineering Optimization	S. S. Rao	New Age International
2.	Operations Research	A. H. Taha	Prentice Hall of India
3.	Operations Research	P. K. Gupta & D. S. Hira	S. Chand & Co.
4.	Operations Research	A. D. Belegundu	Prentice Hall of India
5.	Operations Research	C. K. Mustafi	New Age International

Subject Code : MET-723B
Title of the course : Smart Manufacturing

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: understand the concept of smart manufacturing
CO2: identify the intricacy of data management system
CO3: apply various tools for smart manufacturing
CO4: understand the concept of KPIs and Manufacturing execution systems
CO5: identify the cases studies using modern manufacturing operations management.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO4	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO5	2	2	3	3	3	2	2	2	1	1	2	3	2	1	1
Average	2	2	3	3	3	2	2	2	1	1	2	3	1.2	1.6	1

Main Topics & Course Outline	*Lectures*
UNIT-I	
Introduction	
Introduction to the concept of smart manufacturing (SM): plant-wide optimization; agile supply chain, sustainable production; Important constituents of smart manufacturing; Application and benefits of smart manufacturing	**5**
Layers in smart manufacturing	
Manufacturing ecosystem; Multiple layers of data management: macro, meso, micro	**3**
SM platforms	
Architecture of SM platforms; flexibility; interpretability; scalability; optimization of manufacturing operations.	3
Tools and equipment	
Tools and equipment required for SM; SM App store.	3
UNIT-II	
Manufacturing execution systems	
Introduction to the manufacturing execution systems (MES), tools and techniques; MES key performance indicators (KPIs); Applications and advantages of MES.	5
Manufacturing operations management	
Introduction to manufacturing operations management (MOM), tools and techniques; MOM key performance indicators; Applications and advantages of MOM.	5
Recent issues in smart manufacturing	
Integrating factory and enterprise information with supply chain; integrating factory with smart grid; phases of smart manufacturing; smart manufacturing test-bed.	4
Case studies	
Industry case studies on: smart factories, integrating factories and enterprise with smart grid, strategic decision making, etc.	12
Recommended Books	

Title	*Author(s)*	*Publisher*
Smart Manufacturing with Artificial Intelligence	Jake Krakauer	
Robotics in Smart Manufacturing	Pedro Neto, António Paulo Moreira.	Springer

Subject Code : MET 723D

Title of the course : ARC PHYSICS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Learn and understand different physical properties of fluids at elevated temperatures.

CO2: Learn and understand the concept of electricity and magnetism.

CO3: Learn and understand about the basic concepts of fluid and magneto fluid dynamics and apply this fundamental knowledge for understanding electric arc in welding.

CO4: Learn about metal transfer and mass flow in the weld pool and apply this knowledge for understanding its implications on the weld strength.

CO5: Learn and understand the concept of high power density welding.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	1	2	2	1	1	1	2	1	2	1	1	2
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	1	1
CO4	3	3	2	3	3	2	3	2	3	1	2	1	2	2	1
CO5	3	3	3	3	3	3	3	3	3	1	3	3	1	2	1
Average	3	2.8	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Theory:

SECTION I

PHYSICAL PROPERTIES OF FLUIDS AT ELEVATED TEMPERATURES

Introduction, gases, dissociation and ionization, the equation of state of a gas at elevated temperature, the equilibrium constant, evaluating the degree of dissociation and ionization,

specific heat, transport phenomena, particle encounters in a slightly ionized gas, particle encounters in an highly ionized plasma, electrical conductivity, thermal conductivity, viscosity, calculating the transport coefficients, liquid metals, vapour pressure, surface tension, viscosity

6

ELECTRICITY AND MAGNETISM

Fundamentals like Electrons and ions, electrostatics, Gauss's law, the magnetic force, the law of Biot and Savart, electromagnetic induction, the Maxwell stress and the force on a conducting body, the force acting on a liquid drop carrying an electric current, the current density and ohms law, the pinch instability: an approximate solution, the dynamics of instability in fluid cylinder, predicted behaviour of perturbed cylinder: radial pinch, higher unstable modes, the effect of an externally applied magnetic field, the growth rate constant, the effect of viscosity on the instability of a fluid cylinder.

6

FLUID AND MAGNETO FLUID DYNAMICS

Introduction, the continuity equation, the momentum equation, momentum, pressure, viscosity, Lorentz force, other forces, and the equilibrium condition, the stream function, the components of stress, the Bernoulli equation, solutions of the momentum equation, laminar flow from a point source of momentum with no electric current: the steady jet, the fluid pressure in the jet, the steady jet with a heat source, laminar flow from a point source in a semi-infinite fluid (no electric current), laminar flow in a semi-infinite fluid having a point source of current in the plane ($\theta=\pi/2$), laminar flow in a semi-infinite fluid: the linear solution, the time-dependent development of flow due to a point source of current in a semi-infinite region, breakdown of the solution to the non-linear problem, other limitations to analytical solutions of the momentum equation, laminar flow in a liquid drop immersed in a conducting fluid carrying an electric current, distortion of the liquid drop, an ellipsoid of revolution in a conducting fluid: the drag coefficient, laminar flow in a hemisphere having a point source of current at the origin, flow in a container induced by a distributed current source.

6

THE ELECTRIC ARC

Introduction, general description of glow and arc discharges, principal characteristics of the electrode regions of arcs, high electric and thermal fields, contraction, classification based on degree of contraction: range of observed current density, glow and arc cathode; glow and arc plasma; glow and arc cathode and abode falls, distinction between thermionic and non-thermionic cathodes, the lo voltage non-thermionic cathode, surface clean up and movement in

magnetic field including retrograde motion, vapour and plasma jets; force on cathode, electrode material and surface state, mature of gas or vapour, value of current, gas pressure; vacuum arcs, theories of the cathode mechanism, the glow cathode: the thermionic cathode, theories of the non-thermionic cathode, the arc column, the anode, theory of glow anode, anode fall voltage and current density, energy balance at the anode, plasma and vapour jets.

6

SECTION-II

THE ELECTRIC ARC IN WELDING

Introduction, structural features, overall electrical characteristics, the total arc characteristics at various pressures, relationship between power source and arc characteristics, arc efficiency, cathode phenomena, cathode phenomena, cathode phenomena and characteristics: thermionic cathodes, the potential drop adjacent to a thermionic cathode, cathode phenomena and characteristics: non-thermionic cathodes, anode phenomena, anode characteristics, the anode at the tip of the rod, the heat balance at the anode, the depth of the anode drop zone, the arc column, the energy flux in the arc column, the ac column temperature, mass flow in the arc column, the effect of pressure variation on the arc column, calculating mass and heat flow in the arc column, arc stiffness and arc blow, controlling arc stiffness and arc force.

8

METAL TRANSFER AND MASS FLOW IN THE WELD POOL

Metal transfer, introduction, the effect of static forces in drop detachment, the pinch instability in GMA welding, other unstable modes, the burn off rate, the drop temperature, the drop transfer rate, the pinch model applied to the droplet transfer rate, transfer of drops across the arc, the arc force, the weld pool, flow in the weld pool, the weld pool temperature, the shape of the weld pool and the reinforcement bead, the effect of composition and surface condition on the shape of the weld pool.

8

HIGH POWER DENSITY WELDING

Introduction, keyholing, range of power densities in welding processes (a) high power densities, (b) intermediate power densities, (c) & (d) low power densities, threshold power density for vaporization, size of the keyhole, discussion on forces acting within the keyhole, forces tending to form and maintain the keyhole like beam pressure, vapour pressure, recoil pressure, ; forces tending to close the keyhole like Gravitational pressure, Surface tension pressure, pressure

balances for a generalised keyhole a) bottom of the keyhole (closed), b) sides of the keyhole, moving weld pool.

8

Reference books:

1. The Physics of Welding by J. F. Lancaster, Publisher: Pargamon Press.
2. Advanced joining technologies by T. W. Eager, Publisher: Chapman & Hall

Subject Code : MET-723E
Title of the course : Design of Weldments

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students should be able to

CO1: Understandings of thetheories of fracture mechanics, types of fractures.

CO2: Understand the mechanical properties and the behavior of the welded components operating at varying temperatures are given to students which in turn enlighten them to understand and interpret the materials and its properties in a better perspective.

CO3: To identify, construct and examine the types of welded joints their significance and applications

CO4: The safety measures against the setting up and means of controlling residual stresses help students to design and fabricate the weld components with enhanced service life.

CO5: To control distortion and the prevention of distortion.

Pre-requisite knowledge:

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Program Specific Outcomes (PSO)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	2	2	1	1	1	2	1	2	1	1	1
CO2	3	3	1	2	3	2	2	1	2	1	2	2	1	1	2
CO3	3	3	3	3	3	3	2	3	3	3	1	2	1	2	1
CO4	2	1	2	3	3	2	3	2	3	1	2	1	2	2	2
CO5	1	2	3	3	3	3	3	3	3	1	3	3	1	1	1
Avera ge	2.4	2.4	2	2.4	2.8	2.4	2.2	2	2.4	1.6	1.8	2	1.2	1.4	1.4

Course Description	**Lecture(s)**
Unit-I	
Fracture in Metals	
Types of fracture mainly: Ductile fracture, Brittle fracture, Intergranular fracture, Various factors/conditions affecting type of fracture	**05**
Fracture Mechanics	
Assessment of fracture toughness, Griffith's theory of fracture mechanics, Brittle fracture test parameters, Procedure for evaluating propensity for brittle fracture, Fracture mechanics testing of ductile metals, Crack arrest-principles and methods of crack arrest	**10**
Mechanical Properties at Low Temperature	
Strength at low temperature, Impact toughness at low temperature, Energy absorption in Impact	**04**

testing, Test methods for toughness evaluation.	
Fatigue	
Definition and meaning of fatigue of metals, Mechanism of fatigue failure, S-N diagram, Factors affecting fatigue life	**05**
Unit-II	
Weld Joints Types of welds and welded joints, Different types of edge preparation and factors affecting their selection.	**04**
Welding Symbols	
Primary and secondary weld symbols, location of welding symbols on drawings.	**05**
Weld design for static loading	
Salient weld design features, Fundamental formulas for design under different types of loading like tension, compression, bending, torsion and impact loading	**08**
Residual Stresses in Weldments	
Definition, causes of development of residual stresses, Residual stresses in specific materials and joints, Methods of controlling residual stresses in Weldments	**03**
Distortion in Weldments	
Definition, and types of distortion in weldments, Various causes and control of distortion, in weldments	**04**

Total=48

Recommended Books:

1. Welding Engineering & Technology by R.S. Parmar (Khanna Publications)
2. Welding Metallurgy (Volume-1) by George E.Linnert (AWS)
3. Design of Welded Structures by Blodgett, (Lincoln Electric Co.)
4. Modern Arc Welding Technology by S.V. Nadkarni (Oxford & IBH)
5. Design of Welded Structures by Pellini, W.S ISBN: 0-85300-166-9 (The Welding Institute, UK)
6. AWS Welding Handbook Volume-1 Leonard. P. Connor AWS
7. Standard Methods for Mechanical Testing of Welds ANSI/AWS B4.0-92