SEM 4 ME

Syllabus

Course Name: Casting and Welding of Metals **[2:0:2=3]**

Course Content:

Fundamentals of Metal Casting: Introduction, Solidification of metals, Fluid flow, fluidity of molten metal, Heat transfer, Defects; Metal Casting Processes and Equipment: Introduction, Expendable-mold, Permanent pattern Casting Processes, Expendable-mold, Expendable-pattern Casting Processes, Permanent mold casting processes, Mold-less casting, Continuous Casting, Casting techniques for single crystal components, Rapid-solidification, Melting-practice and Furnaces, Foundries and Foundry- Automation; Metal Casting: Design, Materials: Introduction, Design considerations in casting, Casting alloys. Powder Metallurgical processes: Introduction, Production of metal powders; Compaction; Sintering; HIP, CIP. Fundamentals of Welding, brazing and soldering, different techniques, and welding defects; Heat-Affected Zone.
Metalcasting and Welding laboratory: Casting related Product development and manufacture: Project involves product conceptualization, design, 3D printing of patterns, melting and casting. Welding of metals using MIG, TIG, Resistance welding followed by microstructural examination of the HAZ using metallographic techniques.

Course Outcomes:

CO1: Understanding the fundamentals of metal casting & welding processes•
CO2: Analysing the casting and welding parameters, methods and defects
CO3: Design and manufacture products through appropriate casting/ welding processes

Textbook:

1. Serope Kalpakjian, Steven R. Schmid, 2010, Manufacturing Engineering and Technology, Sixth Edition (or later), Prentice Hall International.

Reference Book:

1. William D. Callister, Jr., 2011, Materials Science and Engineering: An Introduction, Eight Edition, John Wiley & Sons Inc.
2. Michael F Ashby, 2006, Materials selection in mechanical design, Fourth Edition, McGraw Hill Inc

Course Name: Computer Aided Design & Manufacturing [2:1:2=4]

Course Content:

Theory:

- **CAD**: Introduction, 2-D & 3-D transformations & introduction to Geometric modelling.
- **Wireframe modelling** (Introduction, parametric & non-parametric formulation, and application): Analytic type: Point, Straight lines, Arc, Circles, Ellipse, Parabola, hyperbola & Synthetic type: Hermite cubic spline, Bezier curves, B-spline curves & non-uniform rational B-splines.
- **Surface modelling**: plane surface, ruled surface, surface of revolution, tabulated surface, Hermite Bi-cubic surface, Bezier surface, B-spline surface & coons' surface.
- **Solid modelling**: Boundary representation (BREP), Constructive solid geometry (CSG), Sweep representation, Primitive instancing, Cell decomposition & Analytical solid modelling.
- **Data exchange standards**: IGES, STEP & STL translators, preprocessors and postprocessors, translator testing for correct data conversion
- **NC Tool path generation from CAD system**: the concept of computer integrated manufacturing, connecting CAD with automated manufacturing, developing NC part programs using CAD data.

Lab (NX/ Fusion 360/ any other)**:**

- **Introduction to CAD Software** (NX/ Fusion 360/ any other): CAD system Interface, starting with CAD system, creating, opening & saving files.
- **Create & Edit Sketch**: Choosing Sketch Plane, 2D Sketching, Sketch Entities, Sketch Relations & Dimensioning Sketches and Changing Sketch Plane, Edit Using tools like Move, Cut, Copy & Paste.
- **Part Modelling & Editing**: work with features like Extrude, Revolve, Thin & Revolve; creating New Plane, Revolve Cut, Hole, Extrude Cut, Reference Points, Reference Axis, Fillet & chamfer; patterning; and creating features like Shell, Rib, Pocket, Groove, Thread & Emboss.
- **Assembly Modelling**: Adding Components, Moving & Rotating Components, Mating Parts, Checking Clearances, Exploding Assemblies and generating Bill of Materials.
- Data exchange using IGES, STEP & STL translators.
- CNC tool path generation from CAD system for lathe & Milling.

Course Outcomes: At the end of the course, the students should be able to

CO1: Apply basic maths, science, and computer knowledge to automate drawing, drafting, and modelling tasks.

CO2: Develop CAD models for existing and new engineering products.

Textbook:

1) Nanua Singh, *System Approach to Computer-Integrated Design & Manufacturing*. John Wiley & Sons Inc; 1st edition (19 October 1995). ISBN-10 : 0471585173.

Reference books:

1) M Grover & E. Zimmers *CAD/ CAM*. Pearson Publication.
2) Ibrahim Zeid, *Mastering CAD/CAM*. McGraw-Hill, New Delhi.
3) David F. Rogers & J. Alan Adams, *Mathematical Elements for Computer Graphics*. McGraw-Hill.
4) Sham Tickoo, *NX 11 for Engineers and Designers*. Dreamtech Press.

Course Name: Fluid Mechanics & Hydraulic Machines [3:0:2=4]

Course Content:

Introduction to fluid mechanics: Fluids and their properties, Pressure and its measurement: manometers, pressure gauges. Newton's law of viscosity. Different types of fluid flows-steady & unsteady, uniform & non-uniform, laminar & turbulent flows, compressible & incompressible flows. Discharge & mean velocity calculation.

Fluid statics: Pressure on submerged plate, plane & curved surfaces, centre of pressure, stability of floating bodies and concept of metacenter.

Integral flow analysis (systems v/s control volume): Fundamentals of flow visualization. Lagrangian vs. Eulerian description of flow – streamlines, streaklines and pathlines. Reynolds transport theorem – mass, momentum & energy equations. Euler and Bernoulli's equation.

Flow in pipes & ducts: Incompressible flow through ducts & pipes, Boundary layers, water hammer in pipes, fluid friction in pipes & head losses.

Introduction to hydraulic machines: Classification of fluid machinery, Impulse-momentum principle. Moment of momentum equation applied to hydraulic machinery, Euler's equation. Hydrodynamic force of jet on flat and curved surfaces (stationary as well as moving);

Hydraulic pumps: Classification of pumps. Working of centrifugal and reciprocating pumps. Impellor work, specific speed, cavitation, slip and indicator diagram. Differences between centrifugal and reciprocating pumps

Impulse turbines: Principle of operation of impulse turbines, their areas of applications, velocity triangles, calculation of power and efficiency. Pelton Wheel turbine;

Reaction turbines: Principle of operation of reaction turbines. Francis and Kaplan turbines and their multiple variants: velocity triangles, calculation of power and efficiency, degree of reaction, purpose of draft tube, meaning and cause of cavitation in turbines, specific speed, and performance characteristic curves.

Lab Component: Perform experiments and do calculations involving measurements of pressure, flow rate, viscosity and various losses (in pipes). Perform experiments and understand the working of equipment like Pitot tube, Venturi meter and orifice meter, calculate metacentric height of a floating ship model, working of different types of hydraulic turbines and pumps.

Course Outcomes:

CO1. Understand the basic principles and governing equations for various types of fluid flows and perform experiments related to Bernoulli equation and metacenter.

CO2. Solve problems for different types of flows using mass, momentum and energy equations and also calculate the various losses involved with these flows and perform experiments related to pitot tube, venturimeter, orifice meter and finding losses in pipelines.

CO3. Solve problems and perform experiments related to impulse and reaction hydraulic turbines.

CO4. Solve problems and perform experiments related to different kinds of hydraulic pumps.

Textbooks:

1. Frank M. White, *Fluid Mechanics*, 9th Edition, India, Tata McGraw Hill Company, 2022.

Reference Books:

1. Munson, Okiishi, Huebsch, Rothmayer, *Fundamentals of Fluid Mechanics*, 7th Edition, USA, John Wiley & Sons, 2013.
2. Y. Cengel and J. Cimbala, *Fluid Mechanics: Fundamentals and applications*, 4th Edition, India, McGraw Hill Education, 2019.

Course Name: Applied Engineering Thermodynamics [2:0:0=2]

Course Content:

Vapour Power Cycles: Rankine cycle, Methods for improving the efficiency of Rankine cycle, Ideal Reheat and Regenerative cycles, Binary vapour cycles, combined gas - vapour power cycles, Analysis of power cycles

Gas Power Cycles: Air standard cycles, Brayton cycle, Regenerative gas turbine cycle, reheat gas turbine cycle, Ericsson cycle, Stirling cycle

Boilers: Types, Boiler functioning, Boiler mountings and accessories, Boiler draught

Nozzles: Basics of compressible flow. Stagnation properties, isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows

Steam Turbines: Impulse and reaction turbines, Pressure and Velocity compounded turbines, Velocity diagrams for Impulse and reaction turbine.

Course Outcomes:

CO1: Solve problems related to vapour and gas power cycles

CO2: Solve problems related to nozzles and steam turbines and understand working principle and solve problems related to different types of boilers.

Textbook:

1. Y.A.Cengel and M.A.Boles, *Thermodynamics: an Engineering Approach*, (8th edition), New York, McGraw Hill, 2015
2. P.K. Nag, *Power Plant Engineering*, 4th edition, India, Tata Mcgraw-Hill Publishing Company Limited, 2017

Reference Book:

1. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, *Fundamentals of Engineering Thermodynamics,* 8th edition, USA, Wiley, 2014.
2. Claus Borgnakke ; Richard E. Sonntag; Souvik Bhattacharyya; Manoj Kumar Soni, *Fundamentals of Thermodynamics*, 10th edition (Indian adaptation), John Willey & Sons. 2022

Course Name: Mechanics of Solids [3:0:2=4]

Course Content:

- Stress and strain: Tension, compression, and shear stresses; Axial, Transverse and Torsional loading, Deformation in solids; Hooke's law, elastic constants, and their relations, Uni-, Bi- and Tri-axial state of stresses
- Torsion of Shafts; Torque, Shear stresses and Deflection calculations of solid, hollow shafts, stepped shafts.
- State of stress at a point, principal stresses, principal planes, Mohr's circle.
- Beams: Introduction, Types of beams-Simply supported, cantilever, overhanging; types of supports, point and distributed loads, Theory of bending of beams, shear force and bending moment diagrams, bending stress distribution and neutral axis, shear stress distribution, Beam deflections, relation between slope, deflection, and radius of curvature: Double Integration Method, Moment Area Method.

- Strain energy, Stress due to different types of loads, strain energy due to pure shearing, torsion, bending, impact load, Deflection estimation using strain energy.
- Columns: Introduction, types of supports, Euler's theory and buckling of columns, crippling load calculations.

Course Outcomes:

CO1: Understanding the fundamentals concepts of the deformation and stress-strain of various loaded structural components.

CO2: Apply theory of bending, torsion, buckling and strain energy principles on beams, shafts, columns, and structural members respectively.

CO3: Develop the safe design methods/concepts of various critically loaded mechanical structures.

Textbook:

1. Beer, F.P. and Johnston, E.R., *Mechanics of Materials*", 8th Ed., McGraw Hill, 2020.

Reference Book:

1. Russell. C Hibbeler, *Mechanics of Materials*, 9th Edition, Pearson, 2014.
2. Singh D. K,, *Strength of Materials*, 4th Edition, Ane Books Pvt. Ltd., 2016.

Course Name: Practice School II **[4 Credits]**

Course Content:

Practice School at BMU serves as a holistic bridge between industry exposure and university learning, fostering students' proficiency in corporate work settings and deepening their understanding of the dynamic demands and challenges in a professional workplace. This educational initiative promotes experiential and collaborative learning, contributing to innovation and research within the country.

The Practice School-II (PS-II) course is conducted in the summer term immediately following the completion of the 2nd year of the B.Tech. degree programme. The duration of the PS-II course is 6-8 weeks, and it is offered during the summer after students have completed two years of coursework, which includes a well-balanced mix of Foundation, Skill, Perspective, and Core courses.

PS-II holds significance as an integral part of the curriculum. In this course, students are awarded letter grades, and these grades are factored into the CGPA calculations. The PS-II course provides a comprehensive exposure to the professional workplace, allowing students to understand real-time industry scenarios, learn organizational structures and functions, develop personality traits, and enhance communication and presentation skills. This opportunity for practical experience takes place in a company's professional setting, offering students a chance to intern and develop their abilities as industry professionals.

The students address pre-defined problems within the host organization, working independently under the guidance of an Industry Mentor and supported by a Faculty Mentor. Periodic assessments by the Faculty Mentor at the work site ensure ongoing progress. The culmination of PS-III involves the student defending their project work before a departmental panel.

Course Outcomes:

CO1: Demonstrate critical thinking, keen observation, and effective communication skills.

CO2: Attain advanced self-directed learning experiences characterized by depth, complexity, and active engagement within an industrial setting.

CO3: Analyze, evaluate, and critically assess existing solutions and strategies to address real case problems encountered during the internship.