ANDHRA LOYOLA INSTITUTE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)
B.Tech MECHANICAL ENGINEERING (AR24 Regulations)
II YEAR COURSE STRUCTURE & SYLLABUS

B.Tech II Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	BS	Numerical Methods and Transform Techniques	3	0	0	3
2	HSMC	Universal Human Values–Understanding Harmony & Ethical Human Conduct	2	1	0	3
3	Engineering Science	Thermodynamics	2	0	0	2
4	Professional Core	Mechanics of Solids	3	0	0	3
5	Professional Core	Material Science and Metallurgy	3	0	0	3
6	Professional Core	Mechanics of Solids and Materials Science Lab	0	0	3	1.5
7	Professional Core	Computer-aided Machine Drawing	0	0	3	1.5
8	Engineering Science	Python programming Lab	0	0	2	1.0
9	Skill Enhancement Course	Embedded Systems and IoT	0	1	2	2
10	Audit Course	Environmental Science	2	0	0	-
Total			**15**	**2**	**10**	**20**

B.Tech. II Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Management Course-I	Industrial Management	2	0	0	2
2	Basic Science	Complex Variables, Probability and Statistics	3	0	0	3
3	Professional Core	Manufacturing processes	3	0	0	3
4	Professional Core	Fluid Mechanics &Hydraulic Machines	3	0	0	3
5	Professional Core	Theory of Machines	3	0	0	3
6	Professional Core	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7	Professional Core	Manufacturing processes Lab	0	0	3	1.5
8	Skill Enhancement course	Soft Skills	0	1	2	2
9	Engineering Science	Design Thinking &Innovation	1	0	2	2
Total			**15**	**1**	**10**	**21**
Mandatory Community Service Project Internship of 08weeks duration during summer Vacation						

L	T	P	C
2	0	0	2

II Year-I Semester

THERMODYNAMICS

Course Objectives

- Familiarize concepts of heat, work, energy and governing rules for conversion of one form to other.
- Explainrelationshipsbetweenpropertiesofmatterandbasiclawsofthermodynamics.
- Teachtheconceptofentropyforidentifyingthedisorderandfeasibilityofa thermodynamic process.
- Introduce the concept of available energy for maximum work conversion.
- Provide fundamental concepts of Refrigeration and Psychrometry.

Unit-I

Introduction: Basic Concepts : System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility

Unit-II

Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and applications. Limitations of the First Law–Enthalpy, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

Unit-III

Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

Unit-IV

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations– Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer–Steam Calorimetry.

Unit–V

Introduction to Refrigeration :working of Air, Vapour compression, VCR system Components, COP Refrigerants.

Introduction to Air Conditioning**:** Psychrometric properties &processes–characterization of sensible and latent heat loads – load concepts of SHF

Requirementsofhumancomfortandconceptofeffectivetemperature-comfortchart– comfort air conditioning, and load calculations.

Text Books:

1. P.K.Nag,EngineeringThermodynamics,5/e, Tata Mc Graw Hill, 2013.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics,7/e, Wiley, 2009.

Reference Books

1. J.B.Jones,andR.E.Dugan,EngineeringThermodynamics,1/e,PrenticeHall,1995.
2. Y.A.Cengel & M.A.Boles , Thermodynamics – An Engineering Approach, 7/e, McGraw Hill, 2010.
3. P.Chattopadhyay,EngineeringThermodynamics,1/e,OxfordUniversityPress,2011.
4. CPArora,RefrigerationandAir-conditioning,4/e,McGrawHill,2021.

Online Learning Resources:

- https://www.edx.org/learn/thermodynamics.
- https://archive.nptel.ac.in/courses/112/106/112106310.
- https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s
- https://kp.kiit.ac.in/pdf files/02/Study-Material 3rd-Semester_Winter_2021_Mechanical-Engg.- Thermal-Engineering-1_Abhijit-Samant.pdf
- https://www.coursera.org/learn/thermodynamics-intro

Course Outcomes:

COs	Statements	Blooms Level
CO1	Explain the importance of thermodynamic properties related to Conversion of heat energy into work.	L3
CO2	Apply the Zeroth and First Law of Thermodynamics.	L3
CO3	Understand Second Law of Thermodynamics.	L2
CO4	Analyze the Mollier charts, T-S and h-s diagrams, Steam calorimetry Phase Transformations	L4
CO5	Evaluate the COP of refrigerating systems and properties, processes Of psychrometry and sensible and latent heat loads.	L5

II Year I Semester

L	T	P	C
3	0	0	3

MECHANICS OF SOLIDS

Course Objectives: The objectives of the course are to

- Understand the behavior of basic structural members subjected to uniaxial and bi axial loads.
- Apply the concept of stress and strain to analyse and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
- Students will learn all the methods to analyse beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.
- Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
- Design and analysis of Industrial components like pressure vessels.

UNIT–I

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – compositebars–Temperaturestresses-ComplexStresses-Stressesonaninclinedplane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT–II

SHEAR FORCE AND BENDING MOMENT : Definition of beam – Types of beams – Concept of shear force and bending moment–S.F and B.M diagrams for cantilever, simply supported and over hanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads–Point of contra flexure–Relation between S.F. ,B.M and rate of loading at a section of abeam.

UNIT–III

FLEXURAL STRESSES : Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections, Shear centre for triangular section.

UNIT–IV

DEFLECTION OF BEAMS: Bending into a circular arc– slope, deflection and radius of

curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods–Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method, Energy method –application to simple cases.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT–V

THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses–hoop, longitudinal and volumetric strains –changes in dia , and volume of thin cylinders–Thin spherical shells. Wire wound thin cylinders. Lame's equation – cylinders subjected to inside & outside pressures – compound cylinders.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

Text Books:

1. GH Ryder, Strength of materials, Palgrave Macmillan publishersIndiaLtd,1961.
2. B.C. Punmia, Strength of materials,10/e, Lakshmi publications Pvt. Ltd, New Delhi, 2018.

Reference Books:

1.Gere&Timoshenko,Mechanics of materials,2/e, CBS publications,2004.
2.U.C.Jindal, Strength of Materials, 2/e, Pearson Education, 2017.
3.Timoshenko, Strength of Materials Part–I&II,3/e,CBSPublishers,2004.
4. Andrew Pyteland Ferdinand L.Singer, Strength of Materials, 4/e, Longman Publications, 1990.
5. Popov, Mechanics of Solids, 2/e, New Pearson Education,2015.
6. Dr. Sadhu Singh, Strength Of Materials, Khanna Publishers

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc19_ce18/preview.
- https://youtube/iY_ypychVNY?si=310htc4ksTQJ8Fv6.
- https://www.youtube.com/watch?v=WEy939Rkd_M&t=2s
- https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204
- https://www.coursera.org/learn/mechanics-1
- https://www.edx.org/learn/engineering/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-1-linear-elastic-behavior
- https://archive.nptel.ac.in/courses/112/107/112107146/

Course Outcomes:

COs	Statements	Blooms Level
CO1	Learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components	L1
CO2	Analyse beams and draw correct and complete shear and bending Moment diagrams for beams.	L4
CO3	Apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, and moments.	L3
CO4	Model &Analyze the behavior of basic structural members subjected to various loads	L4
CO5	Design and analysis of Industrial components like pressure vessels.	L6

II Year-I Semester

L	T	P	C
3	0	0	3

MATERIAL SCIENCE & METALLURGY

Course Objective:

- Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
- Study the behavior of ferrous and nonferrous metals and alloys and their application in different domains
- Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.
- Grasp the methods of making of metal powders and applications of powder metallurgy
- Comprehend the properties and applications of ceramic, composites and other advanced methods

UNIT–I

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor - SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries–determination of grain size. Imperfections, Slip and Twinning.
Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe_3C.

UNIT–II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheriodal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT–III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe_3C system, annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT–IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling

atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering-Methodsofmanufacturingsinteredparts.Secondaryoperations,Applicationsof powder metallurgical products.

UNIT–V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nano materials and smart materials.

Text Books:

1. S.H.Avner,IntroductiontoPhysicalMetallurgy,2/e,TataMcGraw-Hill,1997.
2. Donald R. Askeland, Essentials ofMaterialsscienceandEngineering,4/e,CL Engineering publications, 2018.

Reference Books:

1. Dr.V.D.kodgire,MaterialScienceandMetallurgy,39/e,EverestPublishingHouse, 2017.
2. V. Raghavan, Material Science and Engineering,5/e,PrenticeHallofIndia,2004.
3. William D. Callister Jr, Materials Science and Engineering: An Introduction,8/e, John Wiley and Sons, 2009.
4. George E. Dieter, Mechanical Metallurgy,3/e,McGraw-Hill,2013.
5. Yip-Wah Chung, Introduction toMaterialScienceandEngineering,2/e,CRC Press, 2022.
6. A V K Suryanarayana, Material Science and Metallurgy, BS Publications,2014.
7. U.C.Jindal,MaterialScienceandMetallurgy,1/e,PearsonPublications,2011.

Online Learning Resources:

- https://archive.nptel.ac.in/courses/113/106/113106032/
- https://www.edx.org/learn/mechanics/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-3-time-dependent-behavior.
- https://www.youtube.com/watch?v=9Sf278j1GTU
- https://www.coursera.org/learn/fundamentals-of-materials-science
- https://www.coursera.org/learn/material-behavior.

Course Outcomes:

COs	Statements	Blooms Level
CO1	Understand the crystalline structure of different metals and study the Stability of phases in different alloy systems.	L2
CO2	Study the behavior of ferrous and non-ferrous metals and alloys and Their application in different domains.	L1
CO3	Understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.	L2
CO4	Grasp the methods of making of metal powders and applications of Powder metallurgy.	L3
CO5	Comprehend the properties and applications of ceramic, composites And other advanced methods.	L4

II Year I Semester

L	T	P	C
0	0	3	1.5

MECHANICS OF SOLIDS & MATERIALS SCIENCEL AB

Course Objective:

- Evaluate the values of yield stress, ultimate stress and bending stress of the given specimen under tension test and bending test
- Conduct the torsion test to determine the modulus of rigidity of given specimen.
- Justify the Rock well hardness test over with Brinell hardness and measure the hardness of the given specimen.
- Examine the stiffness of the open coil and closed coil spring and grade them.
- Analyze the microstructure and characteristics of ferrous and nonferrous alloy specimens.

NOTE: Any 6 experiments from each section A and B.

A) MECHANICSOFSOLIDSLAB:

1. Tensile test
2. Bending test on
   a) Simply supported beam
   b) Cantilever beam
3. Torsion test
4. Hardness test
   a) Brinell's hardness test
   b) Rockwell hardness test
   c) Vickers hardness test
5. Teston springs
6. Impact test
   a) Charpy test
   b) Izod test
7. Punch shear test
8. Liquid penetration test

B) MATERIALSCIENCELAB:

1. Preparation and study of the Microstructure of pure metals.
2. Preparation and study of the Microstructure of Mild steel, medium carbon steels, and High carbon steels.
3. Study of the Microstructures of Cast Irons.
4. Study of the Microstructures of Non-Ferrous alloys.
5. Study of the Microstructures of Heat treated steels.
6. Hardenability of steels by Jominy End Quench Test.

Virtual lab:

1. To investigate the principal stresses σa and σb at any given point of a structural elementormachinecomponentwhenitisinastateofplanestress.(https://virtual-labs.github.io/exp-rockwell-hardness-experiment-iiith/objective.html)
2. To find the impact resistance of mild steel and cast iron.(https://sm-nitk.vlabs.ac.in/exp/izod-impact-test).
3. To find the impact resistance of mild steel.(https://sm-nitk.vlabs.ac.in/exp/charpy- impact-test/index.html)
4. To find the Rock well hardness number of mild steel, cast iron ,brass, aluminum and springsteeletc.(https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test)
5. To determine the indentation hardness of mild steel, brass, aluminum etc. using Vickers hardness testing machine. (https://sm-nitk.vlabs.ac.in/exp/vickers-hardness-test).

Course Outcomes:

COs	Statements	Blooms Level
CO1	Understand the stress strain behavior of different materials.	L2
CO2	Evaluate the hardness of different materials.	L4
CO3	Explain the relation between elastic constants and hardness of materials.	L1
CO4	Identify various micro structures of steels and cast irons.	L3
CO5	Evaluate hardness of treated and untreated steels.	L4

II Year I Semester

L	T	P	C
0	0	3	1.5

COMPUTER –AIDED MACHINE DRAWING

Course Objectives

- Introduce conventional representations of material and machine components.
- Train to use software for 2D and 3D modeling.
- Familiarize with thread profiles, riveted, welded and key joints.
- Teach solid modeling of machine parts and their sections.
- Explain creation of 2Dand 3Dassembly drawings and Familiarize with limits, fits, and tolerances in mating components

The following are to be done by any 2D software package

Conventional representation of materials and components:
Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.
Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.
Welded joints: Lap joint and T joint with fillet, butt joint with conventions.
Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.
Couplings: rigid–Muff, flange; flexible–bushed pin-type flange coupling, universal coupling, Oldham's' coupling.

The following exercises are to be done by any 3D software package:
Sectional views:
Creating solid models of complex machine parts and sectional views.

Assembly drawings: (Any four of the following using solid model software)
Lathe tool post, tool head of shaping machine, tail-stock, machine vice, gate valve, carburetor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling.
Production drawing:
Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Textbooks:

1 Machine Drawing by K.L. Narayana, P.Kannaiah and K.VenkatReddy,NewAge InternationalPublishers,3/e,2014
2 Machine drawing by N.Sideshwar, P. Kannaiah, V.V.S.Sastry, TMH Publishers. 2014.

Reference Books:

1. Cecil Jensen, Jay Helsel and Donald D.Voisinet, Computer Aided Engineering Drawing, Tata McGraw-Hill, NY, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D.Bhatt, Machine Drawing, Charotar Publishers, 50/e,2014.

Online Learning Resources:

- https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf
- https://archive.nptel.ac.in/courses/112/105/112105294/
- https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cad-fundamentals?index=product&queryID=c90b35a82a6ef58b0d6f89679c63f6a1&position=2&linked_from=autocomplete&c=autocomplete
- https://www.youtube.com/watch?v=0bQkS3_3Fq4

Course Outcomes:

COs	Statements	Blooms Level
CO1	Demonstrate the conventional representations of materials and Machine components.	L3
CO2	Model riveted, welded and key joints using CAD system.	L6
CO3	Create solid models and sectional views of machine components.	L6
CO4	Generate solid models of machine parts and assemble them.	L5
CO5	Translate3Dassembliesinto2Ddrawings.	L6

II Year II Semester

L	T	P	C
2	0	0	2

INDUSTRIAL MANAGEMENT

Course Objectives: The objectives of the course are to

- Introduce the scope and role of industrial engineering and the techniques for optimal design of layouts
- Illustrate how work study is used to improve productivity
- Explain TQM and quality control techniques
- Introduce financial management aspects and
- Discuss human resource management and value analysis.

UNIT–I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and break down maintenance.

UNIT–II

WORK STUDY: Importance, types of production, applications, work study, method study andtimestudy,worksampling,PMTS,micro-motionstudy,ratingtechniques,MTM,work factorsystem,principlesofErgonomics,flowprocesscharts,stringdiagramsandTherbligs.

UNIT–III

STATISTICAL QUALITY CONTROL: Quality control, Queuing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts–$\bar{X}$ and R–charts X and S charts and their applications, numerical examples.

TOTALQUALITYMANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts

UNIT–IV

FINANCIAL MANAGEMENT: Scope and nature of financial management, Sources of finance, Ratio analysis, Management of working capital, estimation of working capital requirements, stock management, Cost accounting and control, budget and budgetary control, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR, numerical problems.

UNIT–V

HUMAN RESOURCE MANAGEMENT: Concept of human resource management, personnelmanagementandindustrialrelations,functionsofpersonnelmanagement,Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, and types.

VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

Text Books:

1. O.PKhanna,IndustrialEngineeringandManagement,DhanpatRaiPublications (P)Ltd,2018.
2. Martand Telsang, Industrial Engineering and Production Management, S.Chand &Company Ltd. New Delhi, 2006.

Reference Books:

1. Bhattacharya D K, Industrial Management, S. Chand, publishers,2010.
2. J.G Monks, Operations Management,3/e, McGraw Hill Publishers1987.
3. T.R.Banga, S.C.Sharma, N.K. Agarwal, Industrial Engineering and Management Science, Khanna Publishers, 2008.
4. Koontz O'Donnell , Principles of Management,4/e,McGrawHillPublishers,1968.
5. R.C. Gupta, Statistical Quality Control, Khanna Publishers,1998.
6. N V S Raju, Industrial EngineeringandManagement,1/e, Cengage India Private Limited, 2013.

Online Learning Sources

- https://onlinecourses.nptel.ac.in/noc21_me15/preview
- https://onlinecourses.nptel.ac.in/noc20_mg43/preview
- https://www.edx.org/learn/industrial-engineering
- https://youtube.com/playlist?list=PL299B5CC87110A6E7&si=TghLCbEobuxjEaXi
- https://youtube.com/playlist?list=PLbjTnj-t5Gkl0z3OHOGK5RB9mvNYvnImW&si=oaX_5RG69hS3v2ll

Course Outcomes:

COs	Statements	BloomsLevel
CO1	Learn about how to design the optimal layout	L1
CO2	Demonstrate work study methods	L3
CO3	Explain Quality Control techniques	L2
CO4	Discuss the financial management aspects and	L2
CO5	Understand the human resource management methods.	L2

II Year II Semester

MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

Course Objective: The objectives of the course are to

- Know the working principle of different metal casting processes and gating system.
- Classify the welding processes, working of different types of welding processes and welding defects.
- Know the nature of plastic deformation, cold and hot working process, working of a rolling mill and types, extrusion processes.
- Understand the principles of forging, tools and dies, working of forging processes.
- Know about the Additive manufacturing.

UNIT–I

Casting: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores, Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting and shell molding.

UNIT–II

Welding: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro–slag welding.

Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering &Brazing.

Heat affected zones in welding; pre & post heating, welding defects–causes and remedies.

UNIT–III

Bulk Forming: Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging-Types of Forging, forging defects and remedies; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

UNIT–IV

Sheet metal forming-Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electro hydraulic forming, rubber pad forming, advantages and limitations.

UNIT-V

Additive manufacturing - Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photo polymerization AM Processes,Extrusion-BasedAMProcesses,PowderBedFusionAMProcesses,Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications

Text books:

1. Kalpak jain Sand Steven R S chmid, Manufacturing Processes for Engineering Materials,5/e, Pearson Publications, 2007.
2. P.N.Rao,ManufacturingTechnology-VolI,5/e,McGrawHillEducation,2018.

Reference Books:

1. A.Ghosh & A.K.Malik, Manufacturing Science, East West Press Pvt.Ltd, 2010.
2. Lindberg andRoy,Processesandmaterialsofmanufacture,4/e, Prentice Hall India Learning Private Limited, 1990.
3. R.K.Jain, Production Technology, Khanna Publishers, 2022.
4. Sharma P.C.,A Textbook of Production Technology,8/e, S Chand Publishing, 2014.
5. H.S.Shaun,ManufacturingProcesses,1/e,PearsonPublishers,2012.
6. WAJ Chapman, Workshop Technology, 5/e, CBS Publishers &Distributors Pvt. Ltd, 2001.
7. Hindustan Machine Tools, Production Technology, Tata Mc Graw Hill Publishers, 2017.
8. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2/e, Springer, 2015.

Online Learning Resources:

- https://www.edx.org/learn/manufacturing/massachusetts-institute-of-technology-fundamentals-of-manufacturing-processes
- https://onlinecourses.nptel.ac.in/noc21_me81/preview
- www.coursera.org/learn/introduction-to-additive-manufacturing-processessera
- https://archive.nptel.ac.in/courses/112/103/112103263/
- https://elearn.nptel.ac.in/shop/nptel/principles-of-metal-forming-technology/?v=c86ee0d9d7ed

Course Outcomes:

COs	Statements	Blooms Level
CO1	Design the patterns and core boxes for metal casting processes	L6
CO2	Understand the different welding processes	L2
CO3	Demonstrate the different types of bulk forming processes	L3
CO4	Understand sheet metal forming processes	L2
CO5	Learn about the different types of additive manufacturing processes	L2

II Year II Semester

L	T	P	C
3	0	0	3

FLUID MECHANICS & HYDRAULIC MACHINES

Course Objectives: The students completing this course are expected to

- Understand the properties of fluids, manometry, hydrostatic forces acting on different surfaces
- Understand the kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
- Understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

UNIT I

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure–Manometers- Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.
Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of meta center height. Stability analysis and applications.

UNIT II

Fluid Kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flownet, source and sink, double and vortex flow.
Fluid dynamics: surface and body forces–Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend.
Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes-pipesinseriesandpipesinparalleltotalenergylinehydraulicgradientline.

UNIT III

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum And Energy thickness, separation Of Boundary layer, control of flow separation, Streamlined body, Bluff body and its applications, basic concepts of velocity profiles.
Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT IV

Basics of turbo machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.
Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton

wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design–draft tube-theory-functions and efficiency.

UNITV

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems-hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics–amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies-specificspeed-pumpsinseriesandparallel-performancecharacteristiccurves, cavitation & NPSH. **Reciprocating pumps:** Working, Discharge, slip, indicator diagrams.

Text Books:

1. Y.A. Cengel, J.M.Cimbala, Fluid Mechanics, Fundamentals and Applications,6/e,McGraw Hill Publications, 2019.
2. Dixon, Fluid Mechanics and Thermodynamics of Turbo machinery, 7/e,Elsevier Publishers, 2014.

Reference Books:

1. P N Modi and S M Seth, Hydraulics &Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017.
2. R K Bansal, Fluid MechanicsandHydraulicMachines,10/e, Laxmi Publications (P)Ltd, 2019.
3. Rajput, Fluid Mechanics and Hydraulic Machines, S Chand&Company,2016.
4. D.S.Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria &Sons,2013.
5. D.RamaDurgaiah, Fluid Mechanics and Machinery,1/e,NewAgeInternational, 2002.

Online Learning Resources:

- https://archive.nptel.ac.in/courses/112/105/112105206/
- https://archive.nptel.ac.in/courses/112/104/112104118/
- https://www.edx.org/learn/fluid-mechanics
- https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in
- www.coursera.org/learn/fluid-powerera

Course Outcomes:

COs	Statements	Blooms Level
CO1	Understand the basic concepts of fluid properties.	L2
CO2	Estimate the mechanics of fluids in static and dynamic conditions.	L5
CO3	Apply the Boundary layer theory, flow separation and dimensional analysis.	L3
CO4	Estimate the hydro dynamic forces of jet on vanes in different positions.	L5
CO5	Understand the working Principles and performance evaluation of Hydraulic pump and turbines.	L2

L	T	P	C
3	0	0	3

II Year II Semester

THEORY OF MACHINES

Course Objectives: The objectives of the course are to make the students learn about

- Introduce various basic mechanisms and their applications.
- Explain importance of degree of freedom.
- Familiarize velocity and acceleration in mechanisms.
- Describe the cams and follower motions.
- Explain the importance of gyroscopic couples.
- Introduce the equation of motion for single degree of freedom system.

UNIT–I: Simple Mechanisms

Simple Mechanisms: Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, mobility – Grashof's law, kinematic inversions of four bar chain and slider crank chains- Limit positions – Mechanical advantage- Transmission angle- Description of some common mechanisms-Quick return mechanism, straight line mechanisms–Universal Joint–Rocker mechanisms.

UNIT–II: Plane and motion analysis

Plane and motion analysis: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations – kinematic analysis of simple mechanisms – slider crank mechanism dynamics–Coincident points–Coriolis component of acceleration, Introduction to governors.

UNIT–III: Gyroscope &Gear Profile

Gyroscope: Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two wheeler, simple problems

Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting–helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

UNIT–IV: Balancing of Rotating masses &Cams Balancing of Rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods.

Cams: Classification of cams and followers-Terminology and definitions–Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – derivatives of follower motions-specifiedcontourcams-circularandtangentcams–pressureangleandundercutting.

UNIT–V: Vibrations & Turning Moment Diagrams and Fly wheels

Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility.

Turning Moment Diagrams and Flywheels: Turning moment diagrams for steam engine, I.C engine and Multi Cylinder Engine. Crank effort –coefficient of fluctuation of energy, coefficient of fluctuation of speed– Fly Wheel and their design, fly wheels for punching press.

Text Books:

1. S.S.Rattan,TheoryofMachines,4/e,TataMc-GrawHill,2014.
2. P.L.Ballaney,TheoryofMachines&Mechanisms,25/e,KhannaPublishers,Delhi,2003.

Reference Books:

1. F.Haidery, Dynamics of Machines,5/e,NiraliPrakashan,Pune,2003.
2. J.E.Shigley, Theory of Machines and Mechanisms, 4/e,Oxford,2014.
3. G.K.Groover, Mechanical Vibrations,8/e,NemchandBros,2009.
4. Norton,R.L.,DesignofMachinery–AnIntroductiontoSynthesisandAnalysisof Mechanisms and Machines, 2/e, McGraw Hill, New York, 2000.
5. William T. Thomson, Theory of vibrationwithapplications,4/e,Engle wood Cliffs,N.J.: Prentice Hall, 1993.

Course Outcomes:

COs	Statements	Blooms Level
CO1	Understand different mechanisms and their inversions.	L2
CO2	Calculate velocity and acceleration of different links in a mechanism	L4
CO3	Apply the effects of gyroscopic couple in ships, aero planes and road vehicles.	L3
CO4	Evaluate unbalance mass in rotating machines.	L5
CO5	Analyze free and forced vibrations of single degree freedom systems.	L4

II Year II Semester

L	T	P	C
0	0	3	1.5

FLUID MECHANICS &HYDRAULIC MACHINES LAB

Course Objective: To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

List of Experiments

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orifice meter.
10. Determination of friction factor for a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter.

Virtual Lab:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html)
2. To calculate Total Energy at different points of venture meter. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/bernoulli/introduction.html).
3. To calculate the flow(or point) velocity at center of the given tube using different flow rates.(https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html)
4. To determine the hydrostatic force on a plane surface under partial submerge andfullsubmergecondition.(https://me.iitp.ac.in/Virtual-Fluid-Laboratory/cop/introduction.html).
5. To determine the discharge coefficient of a triangular notch. (https://me.iitp.ac.in/Virtual-Fluid-Laboratory/notch/introduction.html)
6. To determine the coefficient of impact of jet on vanes. (https://fm-nitk.vlabs.ac.in/exp/impact-of-jet).
7. To determine friction in pipes.(https://fm-nitk.vlabs.ac.in/exp/friction-in-pipes/index.html).

Course Outcomes:

COs	Statements	Blooms Level
CO1	Demonstrate the devices used for measuring flow.	L3
CO2	Compute major losses in pipes.	L5
CO3	Illustrate the operating parameters of turbines.	L2
CO4	Explain the working of different types of pumps.	L2
CO5	Explain the devices used for measuring flow.	L2

II Year II Semester

L	T	P	C
0	0	3	1.5

MANUFACTURING PROCESSES LAB

Course Objective: Acquire practical knowledge on Metal Casting, Welding, Press Working and Processing of Plastics.

List of Experiments

1. Design and making of pattern
   i. Single piece pattern
   ii. Split pattern
2. Sand properties testing
   i. Sieve analysis(dry sand)
   ii. Clay content test
   iii. Moisture content test
   iv. Strength test(Compression test &Shear test)
   v. Permeability test
3. Mould preparation
   i. Straight pipe
   ii. Bent pipe
   iii. Dumble
   iv. Gear blank
4. Gas cutting and welding
5. Manual metal arc welding
   i. Lap joint
   ii. Butt joint
6. Injection Molding
7. Blow Molding
8. Simple models using sheet metal operations
9. Study of deep drawing and extrusion operations
10. To make weldments using TIG/MIG welding
11. To weld using Spot welding machine
12. To join using Brazing and Soldering
13. To make simple parts on a3Dprinting machine
14. Demonstration of metal casting.

Virtual Lab:

1. To study and observe various stages of casting through demonstration of casting process.(https://virtual-labs.github.io/exp-sand-casting-process-dei/theory.html)
2. To weld and cut metals using an oxyacetylene welding setup. (https://virtual-labs.github.io/exp-gas-cutting-processes-iitkgp/index.html).
3. To simulate Fused deposition modelling process (FDM) (https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process)

4. https://altair.com/inspire-mold/
5. https://virtual-labs.github.io/exp-simulation-cartesian-system-dei/theory.html

Course Outcomes:

COs	Statements	Blooms Level
CO1	Make moulds for sand casting.	L2
CO2	Fabricate different types of components using various manufacturing techniques.	L5
CO3	Adapt unconventional manufacturing methods.	L3
CO4	Develop Different Weld joints.	L6
CO5	Explaindifferenttypesof3dPrintingtechniques.	L2

II Year II Semester

L	T	P	C
1	0	2	2

DESIGN THINKING &INNOVATION

Course Objectives: The objectives of the course are to

- Bring awareness on innovative design and new product development.
- Explain the basics of design thinking.
- Familiarize the role of reverse engineering in product development.
- Train how to identify the needs of society and convert into demand.
- Introduce product planning and product development process.

UNIT–I Introduction to Design Thinking

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT-II Design Thinking Process

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking-person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT-III Innovation

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT-IV Product Design

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT–V Design Thinking in Business Processes

Design Thinking applied in Business &Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Start ups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

Textbooks:

1. Tim Brown, Change bydesign,1/e,HarperBollins,2009.
2. Idris Mootee, Design Thinking for StrategicInnovation,1/e, Adams Media,2014.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press,2018.
2. Shrrutin N Shetty, Design theFuture,1/e,NortonPress,2018.
3. William lidwell, Kritina holden,&Jillbutter,Universalprinciplesofdesign,2/e, Rockport Publishers, 2010.
4. Chesbrough. H, he era of open innovation, 2003.

Online Learning Resources:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview
- https://onlinecourses.nptel.ac.in/noc22_de16/preview

Course Outcomes:

COs	Statements	Blooms Level
CO1	Define the concepts related to design thinking.	L1
CO2	Explain the fundamentals of Design Thinking and innovation.	L2
CO3	Apply the design thinking techniques for solving problems in Various sectors.	L3
CO4	Analyse to work in a multi disciplinary environment.	L4
CO5	Evaluate the value of creativity.	L5