SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)
(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)
Accredited by NAAC with 'A+' Grade.
Recognised as Scientific and Industrial Research Organisation
SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Regulation: R23	**III / IV - B.Tech. I - Semester**

MECHANICAL ENGINEERING

COURSE STRUCTURE
(With effect from 2023-24 admitted Batch onwards)

Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
B23ME3101	Machine Tools & Metrology	PC	3	0	0	3	30	70	100
B23ME3102	Fluid Mechanics & Hydraulic Machines	PC	2	1	0	3	30	70	100
B23ME3103	Design of Machine Elements	PC	2	1	0	3	30	70	100
B23ME3104	Operations Research	HS	1	1	0	2	30	70	100
#PE-I	Professional Elective -I	PE	3	0	0	3	30	70	100
#OE-I	Open Elective-I	OE	3	0	0	3	30	70	100
B23ME3110	Fluid Mechanics & Hydraulic Machines Lab	PC	0	0	3	1.5	30	70	100
B23ME3111	Machine Tools & Metrology Lab	PC	0	0	3	1.5	30	70	100
B23ME3112	Embedded systems & IOT Lab	SEC	0	1	2	2	30	70	100
B23ME3113	Evaluation of Community Service Internship	PR	--	--	--	2	--	50	50
B23MC3101	Employability Skills	MC	2	--	--	--	30	--	30
		TOTAL	**16**	**4**	**8**	**24**	**300**	**680**	**980**

	Course Code	Course
#PE-I	B23ME3105	Mechanical Vibrations
	B23ME3106	Robotics
	B23ME3107	Additive Manufacturing
	B23ME3108	Sensors and Instrumentation
	B23ME3109	MOOCS-I
#OE-I	Student has to study one Open Elective offered by AIDS or AIML or CE or CIC or CSBS or CSG or CSE or CSITor ECE or EEE or IT or S&H from the list enclosed.	

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3101	PC	3	--	--	3	30	70	3 Hrs.

MACHINE TOOLS AND METROLOGY

(For ME)

Course Objectives:

1.	To learn the fundamental knowledge and principles of material removal processes.
2.	To understand the basic principles of lathe, shaping, slotting and planning machines
3.	To demonstrate the fundamentals of drilling, milling and boring processes.
4.	To discuss the concepts of super finishing processes and limits and fits.
5.	To understand the concepts of surface roughness and optical measuring instruments

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Demonstrate** the cutting forces, tool wear, and tool life by applying the mechanics of metal cutting principles.	**K3**
2.	**Demonstrate** various machining operations using single point cutting tools on relevant machine tools.	**K3**
3.	**Demonstrate** various machining operations using multi-point cutting tools on relevant machine tools.	**K3**
4.	**Apply** various grinding and micro-finishing operations to provide desired surface finish. Apply the principles of limits, fits, and tolerances to solve problems in measuring systems.	**K3**
5.	**Use** appropriate linear, angular, and surface measuring instruments to find accurate results.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**FUNDAMENTALS OF MACHINING:** Elements of cutting process - Single point cutting tools, nomenclature, tool signature, mechanism of metal cutting, types of chips, mechanics of orthogonal and oblique cutting - Merchant's force diagram, cutting forces, Taylor's tool life equation, simple problems - Tool wear, machinability, economics of machining, coolants, tool materials and properties.
UNIT-II (10 Hrs)	**LATHE MACHINES:** Introduction- classification of lathes - Engine lathe - principle of working - construction - specification of lathe - accessories and attachments - lathe operations - taper turning methods and thread cutting - drilling on lathes. **SHAPING AND PLANNING MACHINES:** Introduction - principle of working - principle parts - specifications - operations performed - slider crank mechanism.

UNIT-III (10 Hrs)	**DRILLING & BORING MACHINES:** Introduction - construction of drilling machines - classification of drilling machines - principle of working - specifications- types of drills - operations performed - Boring Machines - types. **MILLING MACHINES:** Introduction - principle of working - specifications - milling methods - classification of Milling Machines -types of cutters - methods of indexing.
UNIT-IV (10 Hrs)	**FINISHING PROCESSES:** Classification of grinding machines- types of abrasives- bonds, specifications and selection of a grinding wheel- Lapping, Honing & Broaching operations- comparison to grinding. **MEASUREMENT SYSTEM:** Concepts of measurement, static performance characteristics, accuracy of measurement and its analysis. **BASICS OF METROLOGY:** Introduction, need of inspection, methods of measurement, precision and accuracy, factors effecting accuracy, errors in measurement. **LIMITS, FITS AND TOLERANCE:** System of limits fits and tolerance, plane limit gauges, Tylor's principle of gauge design, interchangeability and selective assembly.
UNIT-V (10 Hrs)	**LINEAR AND ANGULAR MEASUREMENTS:** tool maker's microscope, slip gauges, optical bevel protractor, sine bar, angle gauges, auto-collimator, straightness, squareness, flatness and roundness measurement. **MEASUREMENT OF SURFACE FINISH:** elements of surface texture, factors effecting surface roughness, sampling length, principle of stylus instrument, stylus and probe instruments (profilometer, Tomlinson surface meter and Tylor Hobson talysurf)

Textbooks:	
1.	Elements Of Workshop Technology Volume-2 by S.K. Hajra Choudhury, Nirjhar Roy; MPP Pvt.Ltd.16th edition ,2023.
2.	Mechanical Measurements, by R.S. Sirohi, H.G. Radha Krishna, Wiley Eastern,Ne Delhi,3rd edition,2013
Reference Books:	
1.	Manufacturing Technology Volume 2 (machine tools) by P N Rao,4th edition,2018
2.	Metal cutting principles by M.C.Shaw, MIT press Cambridge,2002
3.	Production technology by P.C.Sharma, S.Chand and company,2006
4.	Engineering metrology, I.C.Gupta,Dhanpat Rai & sons, Delhi,2018
5.	Engineering Metrology / Kenneth John Hume / Mc Donald,3rd edition,1970
e-Resources	
1.	https://archive.nptel.ac.in/courses/112/105/112105233/
2.	https://archive.nptel.ac.in/courses/112/104/112104250/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3102	PC	2	1	--	3	30	70	3 Hrs.

FLUID MECHANICS AND HYDRAULIC MACHINES

(For ME)

Course Objectives:

1.	Understanding the properties of fluids and principles of buoyancy.
2.	To obtain knowledge on types of fluid flow and applications of continuity and Bernoulli's equations.
3.	Knowledge on fluid flowing through pipe and boundary layer principles.
4.	To obtain the knowledge to draw velocity triangles and on hydraulic turbines
5.	Understanding and analyzing centrifuga land reciprocating pumps

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Apply** the properties of fluids and principles of buoyancy to analyze and solve real-world problems involving fluid behavior and floating bodies	**K3**
2.	**Apply** the principles of fluid kinematics and dynamics in solving problems.	**K3**
3.	**Analyze** and solve fluid flow problems in pipe and understanding boundary layer theory.	**K4**
4.	**Analyze** and evaluate the performance of hydraulic turbines.	**K4**
5.	**Analyze** and evaluate the performance of hydraulic pumps.	**K4**

SYLLABUS

UNIT-I (10Hrs)	**Fluid Statics**: Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Newton law of viscosity. Pressure at a point, **Measurement of pressure**- Piezometer, U-tube, inverted and differential tube manometers, Buoyancy and floating, Meta-centre.
UNIT-II (10 Hrs)	**Fluid Kinematics:** Introduction, methods of describing the fluid motion, Classification of flows, Stream line, path line and streak lines and stream tube, continuity equation, Stream function, velocity potential function. **Fluid Dynamics:** Surface and body forces–Euler's and Bernoulli's equation, Measurement of flow through Venturimeter, Orifice meter and Pitot tube.
UNIT-III (10 Hrs)	**Flow Through Pipes:** Reynolds experiment - Darcy Weisbach equation - Minor losses in pipes - pipes in series and pipes in parallel -total energy line-hydraulic gradient line. **Boundary Layer Theory:** Development of boundary layer along a thin flat plate, laminar boundary layer and turbulent boundary layer, Laminar sub layer, boundary layer separation and its control.

UNIT-IV (10 Hrs)	**Impact of Jets:** Hydrodynamic force of jets on stationary and moving vanes, velocity diagrams, work done and efficiency. Flat, inclined and curved vanes - jet striking centrally and at tip, flow over radial vanes. **Hydraulic Turbines:** Classification of turbines, impulse and reaction turbines, Peltonwheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, draft tube theory, functions and efficiency. Performance of hydraulic turbines, geometric similarity, specific speed, unit quantities, characteristic curves.
UNIT-V (10 Hrs)	**Hydraulic Pumps** **Centrifugal pumps:** classification, working, work done, monomeric head, losses and efficiency, Minimum starting speed, specific speed – pumps in series and parallel – performance characteristic curves, cavitation. **Reciprocating Pumps:** Types, working principle, Power required by a Reciprocating pump, Coefficient of discharge, Slip and negative slip, Effect of acceleration of piston on velocity and pressure in suction and delivery pipes, Indicator diagram.

Textbooks:	
1.	Fluid Mechanics and Hydraulic Machinery, by R. K. Bansal, Laxmi Publications.
2.	Fluid Mechanics- Fundementals and Applications by Y.A. Cengel, J.M.Cimbala, 6th Edn, McGrawHill
Reference Books:	
1.	Hydraulics and Fluid Mechanics Including Hydraulics Machines-P.N.Modi,S.M.Seth, StandardBookHouse
2.	Fluid Mechanics & Hydraulic Machines – R.K.Rajput,S.Chand& Company,
3.	Fluid Mechanics & Fluid Power Engineering – D.S. Kumar, SK. Kataria& Sons Publishers.
4.	Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International.
5.	Fluid Mechanics : Frank M. White,McGrawHill 7th edition
6.	Fluid Mechanics by Pijush K. Kundu and Ira M. Cohen,
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc25_me132
2.	https://onlinecourses.nptel.ac.in/noc25_me144

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3103	PC	2	1	--	3	30	70	3 Hrs.

DESIGN OF MACHINE ELEMENTS

(For ME)

Course Objectives:

1.	Introduce the concepts of design philosophy at basic level, types of loading and different failure criteria.
2.	Acquaint with the design methodology of temporary and permanent joints.
3.	Understand, formulate, and analyze stresses and strains and design various machine elements

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

S.No	Outcome	Knowledge Level
1.	**Design** various machine elements against static loads.	**K4**
2.	**Design** various machine elements against dynamic loads.	**K4**
3.	**Design** temporary and permanent joints required to assemble the machine elements	**K4**
4.	**Design** sliding and roller contact bearings under various environmental and service conditions and Design spur gears based on their load carrying capacity	**K4**
5.	**Design** the shafts and shaft couplings by analyzing the loading conditions.	**K4**

SYLLABUS

UNIT-I (8 Hrs)	**Introduction**: Definition, Classification and Basic Procedure of Machine Design, Basic procedure of Design of Machine Elements. General and Manufacturing considerations in Design of Machine Elements. Indian standard designation of Steels and Cast Irons. Factor of safety and its Selection criteria. **Design for Static Loads:** Design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.
UNIT-II (8 Hrs)	**Design for Dynamic Load:** Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.
UNIT-III (12 Hrs)	**Design of Bolted Joints:** Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening. Design of Eccentrically loaded boltedjoints. **Design of Welded Joints:** Strength of lap and butt welds. Design of symmetrically welded joints subjected to tensile, bending and torsion.Design of Eccentrically loaded welded joints.

UNIT-IV (10Hrs)	**Design of Sliding Contact Bearings:** Lubrication modes, bearing modulus, McKee'sequations, design of full journal bearing. **Design of Rolling Contact Bearings:** Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue. **Design of Gears:** Spur gear terminology, beam strength, Lewis equation, design for dynamic and wear loads.
UNIT-V (10Hrs)	**Power Transmission Shafts:** Design of shafts subjected to bending, torsion and axial loading. Design of Shafts subjected to fluctuating loads using shock factors. **Couplings:** Design various rigid flange couplings

Textbooks:	
1.	Design of Machine Elements by V.B.Bhandari, TMH Publishing Co. Ltd., New Delhi.
2.	A Text Book of Machine Design by R.S.Khurmi, Eurasia Publishing House Ltd., New Delhi
Reference Books:	
1.	Machine Design by Jain, Khanna Publications.
2.	Mechanical Engineering Design by Joseph Edward Shigley, McGraw-Hill Edition
3.	Machine Design by Pandya and Shaw, Charotar publications.
4.	Machine design, an integrated approach by R.L.Norton, Pearson Education
e-Resources	
1.	https://nptel.ac.in/courses/112/105/112105124/
2.	https://nptel.ac.in/courses/112/106/112106137/

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23ME3104	HS	1	1	--	2	30	70	3 Hrs.

OPERATIONS RESEARCH

(For ME)

Course Objectives:

1.	To acquaint the students with basic Operation Research concepts, Formulation of LPP and its solution using various methods.
2.	To build capabilities in the students to analyze the various transportation and assignment problems, job sequencing problems, inventory problems, Games theory and Queuing Models.
3.	To familiarize the students with project management techniques i.e., PERT and CPM .

Course Outcomes: Upon successful completion of the course, the students will be able to

S.No	Outcome	Knowledge Level
1.	**Solve** Linear Programming problems for industrial and business applications	**K3**
2.	**Solve** Transportation and Assignment problems using appropriate methods for different situations	**K3**
3.	**Determine** the optimal solutions for various Job Sequencing and Inventory models for industrial applications.	**K3**
4.	**Demonstrate** various Games theory and Queuing Models in real situations	**K3**
5.	**Solve** various project management problems by CPM & PERT.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**Introduction to OR:** Definition of OR, Characteristics and phases of OR, Scope of OR, OR models, General methods for solving OR models, Roll of computers in OR. **Linear Programming:** Formulation, Graphical Solution, Simplex Method, Artificial Variable Technique-Big-M method.
UNIT-II (12Hrs)	**Transportation Model:** Balanced and Unbalanced Transportation Problems-Initial solution by North West Corner Rule, Lowest Cost Method and VAM, Optimality test by MODI method, Degeneracy in TP. **Assignment Model:** Hungarian algorithm, Balanced and Unbalanced Assignment Problems, Travelling Salesman Problems.
UNIT-III (10 Hrs)	**Job Sequencing:** Introduction, Assumptions, Johnson's algorithm for N-Jobs 2-MachinesProblems, N-Jobs 3-Machines Problems, N-Jobs M-Machines Problems, Graphical solution for 2-Jobs and M-Machines Problems. **Inventory Models:** Definition of Inventory, Costs associated with Inventory Problems, Classification of Models, EOQ & EBQ Models with and without Shortages, Inventory Problems with Price Breakups..

UNIT-IV (12Hrs)	**Game Theory:** Introduction, Basic definitions, Two Person Zero Sum Games, Minimax criterion, Saddle point, Value of game, Solution of games with saddle point, Mixed Strategy Games-Arithmetic method, Dominance principle to reduce size of game, Graphical Method, Algebraic solution to rectangular games. **Queuing Theory:** Structure of Queuing Models, Characteristics of Queuing process, Kendall's notation, Single channel systems-(M/M/1:∞/FIFO) model and (M/M/1:N/FIFO) model.
UNIT-V (10 Hrs)	**Network Analysis:** Introduction, Project scheduling by CPM and PERT, Network diagram representations, Rules to construct Network diagrams, Time estimates in network analysis- EST, EFT, LST, LFT, float/slack and critical path, Time estimates and Probabilityconsiderations in PERT, Crashing in CPM.

Text Books:	
1.	Operations Research by S.D Sharma.
2.	Operations Research by V. K. Kapoor.
Reference Books:	
1.	Operations Research - KantiSwaroop, P.K. Gupta, Man Mohan, SulthanChand&Sons Education.
2.	Operations Research - Hamdy A Taha – Pearson Education.
3.	Operations Research - PanneerSelvan Prentice Hall of India.
4.	Introduction to Operations Research, F.S. Hiller, G.J. Liberman, TMH.
Web links	
1.	https://nptel.ac.in/courses/112/106/112106134/
2.	https://nptel.ac.in/courses/110/106/110106062/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3105	PE	3	--	--	3	30	70	3 Hrs.

MECHANICAL VIBRATIONS

(For ME)

Course Objectives:

1.	To learn basic principles of mathematical modeling of vibrating systems.
2.	To understand the basic concepts free and forced single, two and multi degree freedom systems
3.	To learn the principles involved in the critical speed of shafts.
4.	To understand the basic concepts of Laplace transformations response to different inputs

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

S.No	Outcome	Knowledge Level
1.	Apply the fundamental vibration concepts to model undamped free vibrations in single degree of freedom (SDOF) systems.	K3
2.	Apply vibration concepts to predict the behavior of Single Degree of Freedom (SDOF) systems under damped free and forced vibrations.	K3
3.	Describe the vibration measurement and Solve the problems on critical speed of shafts	K3
4.	Compute the natural frequencies and mode shapes of a two and multi degree of freedom system.	K3
5.	Apply and Analyze the systems subjected to Laplace transformations response to different inputs	K3

SYLLABUS

UNIT-I (8 Hrs)	**Undamped free vibrations of SDOF Systems:** Introduction, basic concepts of vibration, importance of vibration study, elements of a vibrating system, types of vibration, methods of vibration analysis, harmonic motion, Equation of motion, free vibration of undamped translational system, free vibration of undamped torsional system
UNIT-II (10 Hrs)	**Damped free vibrations of SDOF Systems:** introduction, types of damping, free vibration with viscous and coulomb damping, logarithmic decrement. **Forced Vibration of SDOF Systems:** Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), Vibration isolation and motion transmissibility, Energy dissipated due to damping and Problems.
UNIT-III (10 Hrs)	**Vibration Measuring Instruments**: Displacement measuring instruments or vibrometers, Velocity measuring instruments or velocity pick-ups, Acceleration measuring instruments or accelerometers, Frequency measuring instruments.

	Critical Speeds of Shafts: Introduction, critical speed of a light shaft having single discwithout and with damping, critical speed of shaft having multiple discs and secondary critical speed.
UNIT-IV (12Hrs)	**Systems with two degrees of Freedom:** Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, Undamped dynamic vibration absorber. **Multi degree freedom of systems:** Introduction, Free vibrationsequations of motion for multi-degree of freedom systems, matrix method, orthogonality principle, eigen values and eigen vectors, modal analysis.
UNIT-V (8Hrs)	**Laplace transformations** response to an impulsive input, response to a step input, response to pulse(rectangular and half sinusoidal pulse), phase plane method.

Textbooks:	
1.	Mechanical Vibrations by S.S. Rao, 5th Edition, Prentice Hall, 2011.
2.	Elements of vibration Analysis, L.Meirovitch, 2nd Edition, McGraw-Hill,
Reference Books:	
1.	Theory of Vibration with Applications by W.T. Thomson, M.D. Dahleh and C Padmanabhan, 5th Edition,Pearson Education, 2008.
2.	Vibration problems in Engineering by W. Weaver, Jr., S. P. Timoshenko, D. H. Young, John Wiley & Sons.
3.	Mechanical Vibrations by G.K. Grover, Nem Chand & Bros., Roorkee, India.
4.	Mechanical Vibrations by V.P. Singh, Dhanpat Rai & Co. (P) Ltd., Publishers, New Delhi.
5.	Noise and Vibration Control by M.L.Munjal,World Scientific, 2013.
e-Resources	
1.	https://nptel.ac.in/courses/112103111
2.	https://nptel.ac.in/courses/112107212

Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3106	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ROBOTICS

(For ME)

Course Objectives:

1.	Discuss various applications and components of industrial robot systems
2.	Learn about the types of actuators used in robotics
3.	Calculate the forward kinematics and inverse kinematics.
4.	Learn about programming principles and languages for a robot control system
5.	Discuss the applications of image processing and machine vision in robotics

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

S.No	Outcome	Knowledge Level
1.	Find various applications and components of industrial robot systems	**K3**
2.	Demonstrate about the types of actuators used in robotics	**K3**
3.	Calculate the forward kinematics and inverse kinematics.	**K3**
4.	Compute about programming principles and languages for a robot control system	**K3**
5.	Use the applications of image processing and machine vision in robotics.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**INTRODUCTION:** Automation and Robotics, CAD/CAM and Robotics– An overview of Robotics –present and future applications– classification by coordinate system and control system. **COMPONENTS OF THE INDUSTRIAL ROBOTICS:**Robot anatomy, work volume, components, number of degrees of freedom - robot drive systems, function line diagram representation of robot arms, common types of arms –-requirements and challenges of end effectors, determination of the end effectors.
UNIT-II (10 Hrs)	**ROBOT ACTUATORS AND FEED BACK COMPONENTS:** **Actuators:** Pneumatic, Hydraulic actuators, electric& stepper motors. Comparison of Electric, Hydraulic and Pneumatic types of actuation devices. **Feedback components:** position sensors–potentiometers, resolvers, encoders–Velocity sensors.
UNIT-III (10 Hrs)	**MOTION ANALYSIS:** Homogeneous transformations as applicable to rotation and translation –problems. **MANIPULATOR KINEMATICS:** Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics–problems**.**

UNIT-IV (10 Hrs)	**GENERAL CONSIDERATIONS IN PATH DESCRIPTION AND GENERATION:** Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion–Robot programming, languages and software packages-description of paths with a robot programming language.
UNIT-V (10 Hrs)	**IMAGE PROCESSING AND MACHINE VISION:** Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.
Textbooks:	
1.	Industrial Robotics /Groover M P /Pearson Edu.
2.	Introduction to Robotics: Analysis, Control, Applications by Saeed B Niku
Reference Books:	
1.	Introduction to Robotics: Mechanics and Control by J J Craig
2.	Introduction to Robotics by SK Saha, The McGrah Hill Company
3.	Robotics / Fu K S/ McGraw Hill
e-Resources	
1.	**https://youtube.com/playlist?list=PLXDsvE7qtfNdt9oYEhJ_LMXDUGu6bH-L6&si=1NCCkMEjClE5rXHg**
2.	**https://youtube.com/playlist?list=PLJY6IpXCY9VIa9zZz4CT3ssCr4bX_1bzN&si=GbvofVLE0RUPFXkb**

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23ME3107	PE	3	--	--	3	30	70	3 Hrs.

ADDITIVE MANUFACTURING

(For ME)

Course Objectives:

1.	The course is designed to develop fundamental knowledge ofAdditive Manufacturing
2.	Study the liquid-based, solid-based, and powder-basedAdditive Manufacturingtechniques
3.	Learn tools used for Additive Manufacturing
4.	To understand different types of data formats and to explore the applications of AM processes in various fields.

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

S. No	Outcome	Knowledge Level
1.	**Demonstrate** working principles & process parameters of AM	**K3**
2.	**Demonstrate** various liquid and solid-based additive manufacturing processes.	**K3**
3.	**Demonstrate** powder-based AM processes and post-processing methods	**K3**
4.	**Apply** reverse engineering techniques in rapid prototyping.	**K3**
5.	**Apply** rapid tooling methods for AM production.	**K3**

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to AM:** Principle of AM, AM evolution, Generic AM process chain, classification, AM v/s Conventional Machining, Advantages and limitations. **Design for AM**: Preparation of CAD Models – STL File, STL File Format, STL File Problems, Software for Slicing, Newly Proposed Formats, Part Orientation, Support Structure
UNIT-II (10 Hrs)	**Liquid-Based AM:** Stereolithography (SL) – Apparatus, Working Principle, Process Modeling: Process Parameters, photopolymers, photo polymerization, layering technology, advantages, disadvantages, limitations & Applications. case studies. **Solid-Based AM:**Fused Deposition Modelling (FDM), Laminated objectManufacturing (LOM), Ultrasonic AM- Working Principle, process modeling, process parameters, Materials, advantages, Applications, Limitations.
UNIT-III (10 Hrs)	**Powder-Based AM:** Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS) -Working Principle, Processes Modeling, Process Parameters, Advantages, Applications, Limitations. Three dimensional printing (3DP): Models and specifications, process, working principle, applications, advantages and disadvantages, **Post Processing Treatment in AM**: Support Material Removal, Improve surface Quality- Property Enhancements using Non-thermal and Thermal Techniques.

UNIT-IV (10 Hrs)	**Reverse Engineering:** Introduction- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements. **Materials available for AM:** Liquid-Based, Solid-Based, Powder-Based.
UNIT-V (8 Hrs)	**Rapid Tooling:** Introduction - Conventional v/s RT – Classification: Direct and Indirect - Direct v/s Indirect tooling - Direct Methods: Laminated Tooling, DMLS - Indirect Methods: RTV EpoxyTools,3D Keltool - Applications of RT **Application Areas for AM**: Automotive Industry, Aerospace Industry, Medical and Bioengineering applications

Text Books:	
1.	Additive Manufacturing Technologies, Gibson, Ian, David W. Rosen, Brent Stucker, and MahyarKhorasani, Springer, 2021
2.	Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
3.	Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.
Reference Books:	
1.	Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2.	Rapid Prototyping and Engineering applications: A tool box for prototype development, LiouW.Liou, Frank W.Liou, CRC Press, 2007.
3.	Rapid Prototyping: Theory and practice, Ali K. Kamrani, EmadAbouel Nasr, Springer, 2006.
4.	Paul F.Jacobs – “Stereo lithography and other RP & M Technologies”, SME, NY 2011
5.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
Online Learning Resources:	
1.	https://onlinecourses.nptel.ac.in/noc25_me151/preview
2.	https://youtu.be/t7yv4gSnNkE?si=7Cfm5zsYNqxvySv1
3.	https://www.coursera.org/specializations/rapid-prototyping-using-3d-printing

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3108	PE	3	--	--	3	30	70	3 Hrs.

SENSORS AND INSTRUMENTATION

(For ME)

Course Objectives:

1.	To understand the concepts of measurement technology.
2.	To learn the various sensors used to measure various physical parameters.
3.	To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4	To learn about the optical, pressure and temperature sensor
5	To understand the signal conditioning and DAQ systems

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

S.No	Outcome	Knowledge Level
1.	**Explain** fundamental principles of measurement and sensor performance measures for effective instrumentation.	**K2**
2.	**Apply** appropriate motion, proximity and ranging sensors based on their operational principles.	**K3**
3.	**Illustrare** force, magnetic and heading sensors for diverse measurement.	**K3**
4.	**Interpret** operational characteristics of optical, pressure and temperature sensors for their suitability in various sensing tasks.	**K3**
5.	**Determine** basic signal conditioning circuits and data acquisition systems for interfacing with different types of sensors in real world applications.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**INTRODUCTION:** Basics of Measurement-Zero, First and Second order systems, Classification of errors– Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.
UNIT-II (10 Hrs)	**MOTION, PROXIMITY AND RANGING SENSORS** Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).
UNIT-III (10 Hrs)	**FORCE, MAGNETIC AND HEADING SENSORS** Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers. .

UNIT-IV (10 Hrs)	**OPTICAL, PRESSURE AND TEMPERATURE SENSORS** Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors. **limits, fits and tolerance:**system of limits fits and tolerance, plane limit gauges, tylors principle of gauge design, interchangeability and selective assembly.
UNIT-V (10 Hrs)	**SIGNAL CONDITIONING AND DAQ SYSTEMS** Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Textbooks:	
1.	Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2.	Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.
Reference Books:	
1.	C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2.	Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3.	John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4.	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5.	Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

e-Resources	
1.	https://archive.nptel.ac.in/courses/108/105/108105064
2.	https://archive.nptel.ac.in/courses/108/108/108108147/

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23ME3110	PC	-	-	3	1.5	30	70	3Hrs.

FLUID MECHANICS AND HYDRAULIC MACHINES LAB

(For ME)

Course Objectives:

1.	This course will provide a basic understanding off low measurements using various types of flow Measuring devices, calibration and losses associated with these devices
2.	Energy conversion principles, analysis and understanding of hydraulic turbines and pumps will be discussed. Application of these concepts for these machines will be demonstrated. Performance Analysis will be carried out using characteristic curves

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

S.No	Outcome	Knowledge Level
1	Perform Experiments to determine the coefficient of discharge off low measuring devices	K3
2	Conduct experiments on hydraulic turbines and pumps to draw characteristic curves	K4
3	Analyze the practical significance of minor losses and major losses	K4
4	Analyze the performance metrics of hydraulic turbines and pumps.	K4

SYLLABUS

1.	To determine the Coefficient of discharge of Orifice meter.
2.	To determine the Coefficient of discharge of Venturi meter.
3.	To determine the Coefficient of discharge of V-Notch.
4.	To determine the Coefficient of discharge of Rectangular Notch.
5.	To determine the Coefficient of discharge of Trapezoidal Notch.
6.	To determine the friction factor in pipes (Major losses)
7.	To determine the friction factor in pipes (Minor losses)
8.	Performance test on Reciprocating pump.
9.	Performance test on Single stage centrifugal pump.
10.	Experimental investigation on Impact of jet on different vanes.
11.	Performance test on Pelton wheel.
12.	Verification of Bernoulli's Theorem.

Reference Books:

1.	Fluid Mechanics and Hydraulic Machines by Dr.R.K.Bansal

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3111	PC	--	--	3	1.5	30	70	3 Hrs.

MACHINE TOOLS AND METROLOGY LAB

(For ME)

Course Objectives:

1	To understand working principle and perform various operations on machine tools.
2	To demonstrate the fundamentals of Metrology and Measurement concepts.
3	To calibrate measuring instruments and to get familiar with different instruments used for linear and angular measurements.

Course Outcomes:

S.No	Outcome	Knowledge Level
1	Select appropriate machine tool and cutting tool to machine the given specimen into desired product.	K4
2	Assess various surface roughness parameters for the grinded surfaces.	K4
3	Calibrate the accuracy of measuring devices.	K4
4	Calculate linear and angular measurements using different measuring instruments.	K4

SYLLABUS

Machine Tools

1	Perform step turning and taper turning.
2	Perform knurling and thread cutting.
3	Perform form turning and thread cutting.
4	Machining of horizontal, vertical, step and angular surfaces on a shaper.
5	Perform gear cutting on a milling machine.
6	Perform grinding and measure surface parameters.

Metrology

1	Measurement of angle of V-Groove
2	Measurement of taper angle using Dial Gauge and Sine Bar
3	Study and use of Bevel Protractor
4	Measurement of thread parameters on Profile Projector
5	Calibration of Vernier Calipers and Tool Room Microscope.
6	Calibration of Outside Micrometer and Mechanical Comparator.

Reference Books:

1	Elements Of Workshop Technology Volume-2 by S.K. Hajra Choudhury, Nirjhar Roy
2	Manufacturing Technology Volume 2 (machine tools) by P N Rao.
3	Engineering Metrology, LC.Gupta, DhanpatRai& Sons, Delhi.
4	Mechanical Measurements, by R.S. Sirohi, H.G. Radha Krishna, Wiley Eastern

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3112	SEC	0	1	2	2	30	70	3 Hrs.

EMBEDDED SYSTEMS & IOT LAB

(For ME)

Course Objectives: The objectives of the course are

1	To provide the students with hands-on experience in designing purposeful circuits.
2	To help the student to develop a circuit using basic sensors.
3	To enrich the student in using IOT modules in simple circuits.

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

S.No	Outcome	Knowledge Level
1	**Demonstrate** their ability in building simple circuits using Arduino and bread board in TinkerCad.	**K3**
2	**Develop** a circuit to gather the information from various sensors and build a relevant helpful model.	**K3**
3	**Demonstrate** their abilityin controlling DC and servo motors	**K3**

SYLLABUS

1	Build a circuit to light up an LED by choosing an appropriate resistor.
2	Develop a circuit to Switch ON an LED and a buzzer simultaneously.
3	Construct a model to automate LED lighting using photo resister.
4	Generate a PWM output on an LED.
5	Display the analog signal of a potentiometer on a serial monitor and use it to control a DC motor.
6	Build an object detection LED light using IR sensor.
7	Develop a circuit to run a servo motor with the help of a potentiometer.
8	Develop a SONAR circuit i.e. to detect an object using ultrasonic sensor.
9	Build a 4WD car circuit and simulate using serial monitor.
10	Build a circuit to simulate traffic lighting system.
11	Implement the use of Bluetooth module using Arduino/ESP32
12	Getting started with Raspberry Pi

Text Books:

1.	Embedded Systems Architecture by Tammy Noergaard, Elsevier Publications, 2013.
2.	Embedded Systems by Shibu K V, Tata McGraw Hill Education Private Limited,2013.
3.	Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications.
4.	Embedded Systems, Lyla B Das, Pearson Publications, 2013.
5.	Internet of Things- A Hands on Approach, ArshdeepBahga& Vijay Madisetti, Orient Blackswan Private Limited, New Delhi,2015.

e-Resources:

1.	https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2.	https://onlinecourses.nptel.ac.in/noc20_ee98/preview

3.	http://vlabs.iitkgp.ac.in/rtes (Virtual Lab)
4.	https://cse02-iiith.vlabs.ac.in (Virtual Lab)
5.	https://iotvirtuallab.github.io/vlab/Experiments/index.html (Virtual Lab)

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23MC3101	MC	2	--	--		30		

EMPLOYABILITY SKILLS

(For AIML, CSBS, CSE, IT and MECH)

Course Objectives:

1.	To introduce concepts required in framing grammatically correct sentences and identifying errors while using standard English.
2.	To acquaint the learner of making a coherent and cohesive sentences and paragraphs for composing a written discourse.
3.	To inculcate logical thinking in order to frame and use data as per the requirement.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Match various vocabulary items that appear in competitive examinations with their contextual meanings accurately.	K1
2.	Identify grammatical and ungrammatical usage of English language in all the grammar related questions asked in various competitive examinations like CAT, GRE, IBPS.	K3
3.	Infer meaning from complex texts that are set as questions in different competitive examinations held for higher education or employment	K2
4.	Find solutions to complex arithmetic problems set as questions in the competitive examinations held for employment or higher education	K1
5.	Apply logical thinking abilities in solving the problems of reasoning that appear in the examinations like CAT, GRE, GATE, IBPS.	K3

SYLLABUS

UNIT-I (10Hrs)	Synonyms, Antonyms, Frequently Confused Words, Foreign Phrases, Idioms and Phrasal Verbs, Collocations. Spotting Errors, Sentence Improvement
UNIT-II (10 Hrs)	Time and work, Pipes and Cisterns. Time and Distance Problems, Problems on boats and streams. Percentages, Profit and loss, Simple interest and Compound interest. Discount Problems.
UNIT-III (10 Hrs)	Analogies, Odd One Out. (Verbal ability) Number Series, Letter Series, Analogy, Alpha Numeric Series, Order and Ranking, Directions, Data sufficiency, Syllogisms.
UNIT-IV (10 Hrs)	Sentence Completion, Sentence Equivalence, Close Test Reading Comprehension , Para Jumbles

UNIT-V (10 Hrs)	Number System: Divisibility tests, finding remainders in various cases, Problems related to numbers, Methods to find LCM, Methods to find HCF.
Textbooks:	
1.	*How to Prepare for Verbal Ability and Reading Comprehension for CAT* (10th edition) by Arun Sharma and Meenakshi Upadhyay, McGraw Hill Education, 2022.
2.	*How to Prepare for Quantitative Aptitude for CAT (10th edition) by* by Arun Sharma , McGraw Hill Education, 2022.
Reference Books:	
1.	*English Collocation in Use*- Intermediate (2nd edition) by Michael McCarthy& Felicity O'Dell, CUP, 2017.
2.	*Magical Book On Quicker Maths* (5th Edition) By M.Tyra, BSC Publishing Co Pvt. Ltd, 2018.
e-Resources	
1.	www.Indiabix.com
2.	www.800score.com

Regulation: R23	**III / IV - B.Tech. II - Semester**

MECHANICAL ENGINEERING

COURSE STRUCTURE
(With effect from 2023-24 Admitted Batch onwards)

Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
B23ME3201	Heat Transfer	PC	2	1	0	3	30	70	100
B23ME3202	Industrial Engineering and Management	PC	2	1	0	3	30	70	100
#PE-II	Professional Elective -II	PE	3	0	0	3	30	70	100
#PE-III	Professional Elective -III	PE	3	0	0	3	30	70	100
#OE-II	Open Elective-II	OE	3	0	0	3	30	70	100
B23ME3213	Heat Transfer Lab	PC	0	0	3	1.5	30	70	100
B23ME3214	Industrial Engineering Lab	PC	0	0	3	1.5	30	70	100
B23ME3215	Theory of Machines Lab	PC	0	0	2	1	30	70	100
B23ME3216	Tinkering Lab	ES	0	0	2	1	30	70	100
B23BS3201	Soft Skills	SEC	0	1	2	2	30	70	100
B23AC3201	Technical paper writing and IPR	AC	2	--	--	--	30	--	30
	TOTAL		15	3	12	22	330	700	1030

	Course Code	Course
#PE-II	B23ME3203	Advanced Solid Mechanics
	B23ME3204	Design for Manufacturing
	B23ME3205	Computational Fluid Dynamics
	B23ME3206	Energy Storage Technologies
	B23ME3207	MOOCS-II
#PE-III	B23ME3208	Non-destructive Evaluation
	B23ME3209	Renewable Energy Technologies
	B23ME3210	Finite Element Methods
	B23ME3211	Refrigeration and air conditioning
	B23ME3212	MOOCS-III
#OE-II	Student has to study one Open Elective offered by AIDS or AIML or CE or CIC or CSBS or CSG or CSE or CSIT or ECE or EEE or IT or S&H from the list enclosed.	
*Mandatory Industry Internship /Mini Project of 08 weeks duration during summer vacation		

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23ME3201	PC	2	1	--	3	30	70	3 Hrs.

HEAT TRANSFER

(For ME)

Course Objectives: The objectives of the course are to

1.	To learn the different modes of heat transfer and conduction heat transfer through various solid bodies.
2.	To learn the one-dimensional steady state heat conduction heat transfer and one-dimensional transient heat conduction.
3.	To learn the basic concepts of convective heat transfer and force convection heat transfer of external flow and internal flows.
4.	To learn the overall heat transfer coefficient in heat exchangers and boiling and condensation phenomena.
5.	To learn the concepts of radiation heat transfer.

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

S.No.	Outcome	Knowledge Level
1.	**Apply** the modes of heat transfer to solve the problems involving steady state heat conduction in various Cross sections.	**K3**
2.	**Compute** the rate of heat transfer through fin and unsteady state heat conduction in various Cross sections	**K3**
3.	**Apply** the empirical equations for natural and forced convention in various cross section areas.	**K3**
4.	**Compute** the rate of heat transfer with phase change and in the heat exchangers	**K3**
5.	**Apply** theprinciples ofradiation heat transfer between black body and gray body surfaces.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Modes and Mechanisms of Heat Transfer – Basic Laws of Heat Transfer – General Applications of Heat Transfer. **Conduction Heat Transfer:** Fourier Rate Equation – General Heat Conduction Equation in Cartesian, Cylindrical and Spherical Coordinates, Simplification and Forms of the Field Equation – Steady, Unsteady and Periodic Heat Transfer – Boundary and Initial Conditions. **One Dimensional Steady State Heat Conduction:** In Slabs, Hollow Cylinders and Spheres – Overall Heat Transfer Coefficient – Electrical Analogy – Critical Radius/Thickness of Insulation.
UNIT-II (10Hrs)	**Heat Transfer in Extended Surface (Fins): –** efficiency, effectiveness and temperature distribution on Long Fin, Fin with Insulated Tip and Short Fin,

	Application to Errors in Temperature Measurement. **One Dimensional Transient Heat Conduction:** In Systems with Negligible Internal Resistance Significance of Biot and Fourier Numbers – Chart Solutions of Transient Conduction Systems – Problems on Semi-infinite Body.
UNIT-III (10Hrs)	**Convective Heat Transfer: Dimensional Analysis –** Buckingham Π Theorem and Its Application for Developing Semi – Empirical Non-Dimensional Correlations for Convective Heat Transfer – Significance of Non-Dimensional Numbers. **Forced Convection: External Flows:** Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer for flow over – Flat Plates and Circular Cylinders. **Internal Flows:** Concepts of Hydrodynamic and Thermal Entry Lengths - Division of Internal Flow through– Use of Empirical Relations for Convective Heat Transfer in Horizontal Pipe Flow. **Free Convection:** Development of Hydrodynamic and Thermal Boundary Layer along a Vertical Plate – Use of Empirical Relations for Convective Heat Transfer on Plates and Cylinders in Vertical Orientation.
UNIT-IV (10Hrs)	**Heat Transfer with Phase Change: Boiling:** Pool Boiling – Regimes, Determination of Heat Transfer Coefficient in Nucleate Boiling, Critical Heat Flux and Film Boiling. **Condensation:** Film wise and Drop wise Condensation – Nusselt's Theory of Condensation on a Vertical Plate- Film Condensation on Vertical and Horizontal Cylinders Using Empirical Correlations. **Heat Exchangers:** Classification of Heat Exchangers – Overall Heat Transfer Coefficient and Fouling Factor –Concepts of LMTD and NTU Methods – Problems using LMTD and NTU Methods.
UNIT-V (10Hrs)	**Radiation Heat Transfer:** Emission Characteristics and Laws of black-body radiation – Irradiation –total and monochromatic quantities– laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann – heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between gray bodies – radiation shields – electrical analogy for radiation networks.
Note: Heat transfer data book by C P Kothandaraman and Subrahmanyan is allowed.	
Textbooks:	
1.	Heat Transfer, J. P. Holman, TMH Publications, Special Indian edition.
2.	Heat Transfer, P.K.Nag, TMH Publications, Third edition.
3.	Fundamentals of heat and mass transfer" by Frank P. Incropera and David P. Dewitt, Wiley India Pvt Ltd; Fifth edition
Reference Books:	
1.	Heat and mass transfer, R.K. Rajput, S. Chand Publications, Revised edition.
2.	Fundamentals of Engg. Heat and Mass Transfer, R.C.Sachdeva, New Age International Publications, Fifth edition.
3.	Principles of Heat Transfer, Frank Kreith, R. M. Manglik& M. S. Bohn, Cengage learning publishers, Special edition.
4.	Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, Dhanpath Rai & Co. Publications.
5.	Heat and Mass Transfer, Cengel, McGraw Hill Publications, Fifth edition.

e-Resources	
1.	https://nptel.ac.in/courses/112101097/
2.	http://web.mit.edu/lienhard/www/ahttv212.pdf

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3202	PC	2	1	--	3	30	70	3 Hrs.

INDUSTRIAL ENGINEERING AND MANAGEMENT

(For ME)

Course Objectives: The objectives of the course are to

1.	Introduce the scope and role of industrial engineering and the techniques for optimal design of layouts
2.	To know the production activities with reference to planning and control
3.	Illustrate how work study is used to improve productivity
4.	Explain TQM and quality control techniques
5.	Discuss human resource management and value analysis.

Course Outcomes: After completing this course, students will be able to:

S.No	Outcome	Knowledge Level
1.	**Use**principles and quantitative techniques to optimize plant layouts and productivity.	K3
2.	**Apply** production planning techniques to optimize scheduling and process control.	K3
3.	**Demonstrate** method study and time measurement techniques to optimize work processes.	K3
4.	**Apply** SQC techniques and TQM methods to analyze quality data and improve production systems	K3
5.	**Demonstrate** HRM strategies and value engineering for organizational improvement	K3

SYLLABUS

UNIT-I (10 Hrs)	**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 (10 Hrs)	**PRODUCTION PLANNING AND CONTROL:** Types of productions, Production cycle, Product design and development, Process planning, Forecasting (simple problems), Loading, Scheduling, Dispatching, Routing, Progress control.

UNIT-III (10 Hrs)	**WORK STUDY:** Concept of productivity, Method study – Basic steps in work study, method study, Process charts, Diagrams, work sampling ,PMTS, Principles of motion economy, Micro motion study, Therbligs, SIMO chart, Work measurement – Stop watch procedure of time study, Performance rating, Allowances
UNIT-IV (10 Hrs)	**STATISTICAL QUALITY CONTROL:** Quality control, Quality assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts for variables and attributes, numerical examples. **TOTAL QUALITY MANAGEMENT:** Zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts.
UNIT-V (10 Hrs)	**HUMAN RESOURCE MANAGEMENT:** Concept of human resource management, personnel management and industrial relations, functions of personnel management, 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.
Textbooks:	
1.	Industrial Engineering and Management by Dr. O P Khanna
2.	Mart and Telsang, Industrial Engineering and Production Management, S.Chand&Company Ltd.NewDelhi, 2006.
Reference Books:	
1.	Industrial Management/ Bhattacharya DK/Vikas publishers.
2.	Operations Management/ J.G Monks/ McGraw Hill Publishers.
3.	Industrial Engineering and Management Science/T.R.Banga, S.C.Sharma, N.K.Agarwal/, Khanna Publishers.
4.	Principles of Management/ KoontzO' Donnel/ McGraw Hill Publishers.
5.	Statistical Quality Control/ Gupta/Khanna Publishers.
6	Industrial Engineering and Management/ NVS Raju/ Cengage Publishers.
7	Production and Operations Management by Everette Adam & Ronald Ebert
e-Resources	
1.	https://nptel.ac.in/courses/112107292

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3203	PE	3	--	--	3	30	70	3 Hrs.

ADVANCED SOLID MECHANICS

(For ME)

Course Objectives:

1.	To analyze the stresses produced in practical applications of curved bars.
2.	To enrich the student on the concepts of shear force and bending moment diagrams of fixed beams with uniform and non-uniform cross sections, both under stability of supports and sinking of supports.
3.	To make the student understand the concepts of shear force and bending moment diagrams of continuous beams with uniform and non-uniform cross sections, both under stability of supports as well as sinking of supports.
4.	To analyze the stresses produced in thick cylinders and compound cylinders subjected to internal and external pressures.
5.	To analyze the stresses produced in different rotating machine members.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Investigate various curved bars subjected to different loading conditions to **Determine** stresses and strains.	K3
2.	**Compute** Shear Force and Bending Moment values for statically indeterminate fixed beams and sketch Shear Force and Bending Moment diagrams	K3
3.	**Compute** Shear Force and Bending Moment diagrams for continuous beams under various loads and plot the diagrams.	K3
4.	**Calculate** the stress distributions across the cross sections of thick cylinders & compound cylinders.	K3
5.	**Determine** the distribution of stresses produced in various rotating machine members.	K3

SYLLABUS

UNIT-I (10Hrs)	**Bending of Curved Bars:** Winkler-Bach theory of curved bars subjected to uniform bending moment – rectangular, circular, and trapezoidal cross sections, Stresses in a crane hook.
UNIT-II (10 Hrs)	**Fixed Beams:** Relations between fixing moments of a fixed beam of uniform cross section, BMD & SFD of fixed beams of uniform cross section, Effect of sinking of support.
UNIT-III (10 Hrs)	**Continuous beams:**Clapeyron's theorem of three moments for a continuous beam of varying and uniform cross sections, BMD & SFD of continuous beams of uniform cross

	section, Effect of sinking of support.
UNIT-IV (10 Hrs)	**Thick cylinders:** Stresses and strains in thick cylinders subjected to inside and outside pressures, Compound cylinders – stress distributions, initial difference of radii at junction.
UNIT-V (10 Hrs)	**Rotating rings and discs:** Stresses in rotating ring /wheel rim, Radial and circumferential stress distributions in disc of uniform thickness – solid and hollow discs, Disc of uniform strength.

Textbooks:	
1.	Analysis of Structures, Vol. – I by Vazirani and Ratwani, Khanna Publishers
2.	Strength of materials by Sadhu Singh, Khanna Publishers
Reference Books:	
1.	Strength of Materials, by Timoshenko, CBS Publishers and distributors.
2.	Strength of Materials by R. K. Rajput, S. Chand & Co Publishers.
e-Resources	
1.	https://cosmolearning.org/courses/advanced-strength-of-materials/
2.	http://www.infocobuild.com/education/audio-video-courses/mechanical-engineering/AdvancedStrengthOfMaterials-IIT-Bombay/lecture-29.html

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3204	PE	3	--	--	3	30	70	3 Hrs.

DESIGN FOR MANUFACTURING

(For ME)

Course Objectives:

1.	To understand the basic concepts of design for manufacturing
2.	To interpret basic design procedure of machining processes
3.	To interpret the design considerations of various metal joining process.
4.	To interpret the basic design concepts involved in the assembly automation

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Describe** the basic concepts of design for manufacturing.	**K2**
2.	**Apply** basic design procedures to various machining processes.	**K3**
3.	**Apply** the design considerations in metal casting and metal joining processes.	**K3**
4.	**Interpret** the basic design concepts involved in assembly automation.	**K3**
5.	**Explain** the fundamental concepts of Additive Manufacturing.	**K2**

SYLLABUS

UNIT-I (10Hrs.)	**Introduction to DFM, DFMA:** Introduction to DFMA: History of DFM. Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design. Overall Impact of DFMA on Industry. **Design for Manual Assembly:** General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, weight on Handling Time, Effects of Combinations of Factors and application of the DFA Methodology.
UNIT-II (10 Hrs.)	**Machining processes:** Introduction to Manufacturing Process: Classification of manufacturing process, Classification of engineering materials, Basic manufacturing processes, Mechanical properties of material: Tensile properties, Engineering stress-strain, Compression properties, Shear properties, General design recommendations for machined parts.
UNIT-III (10 Hrs.)	**Sand casting:** Introduction to sand casting, Typical characteristics of a sand cast part, Design recommendation for sand casting, Investment casting: Introduction, Steps in investment casting, Design consideration of Investment casting **Metal joining:** Different types of welding processes, Design for recommendation for welding process, Design for solder and brazed assembly: Process, Typical characteristics, Suitable materials, Detail Design recommendations

UNIT-IV (10 Hrs.)	**Forging:** Forging processes, forging nomenclature, Suitable materials for forging, Design recommendations, Metal injection moulded parts: Process, Materials suitable, Design recommendations for metal injection molded parts. **Design for Assembly Automation:** Introduction to Assembly: The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, Assembling a product, Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.
UNIT-V (10 Hrs.)	**Design for Additive Manufacturing:** Introduction to AM, Design tools for AM, Part Orientation, Removal of Supports, hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.
Textbooks:	
1.	Design for Manufacture by Boothroyd
2.	Design for manufacture, James Bralla
Reference Books:	
1.	Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998
2.	ASM Hand book Vol.20
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc19_me48/preview
2.	https://archive.nptel.ac.in/courses/107/103/107103012/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3205	PE	3	--	--	3	30	70	3 Hrs.

COMPUTATIONAL FLUID DYNAMICS

(For ME)

Course Objectives:

1.	Develop an understanding of introductory concepts in computational fluid mechanics with emphasis on the numerical solution of ordinary and partial differential equations.
2.	Able to find solution of ODEs by numerical integration; finite difference and finite volume methods for parabolic, elliptic, and hyperbolic PDEs (techniques for single and multi-dimensional problems); numerical linear algebra.
3.	Able to implement and utilize various numerical methods and basic mathematical analysis for canonical problems in fluid mechanics.
4.	Able to understand formulation of 2D & 3D problems using FVM.
5.	To get acquainted with the application of standard variational problems

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Compute** solutions of governing equations using finite difference and direct methods**.**	**K3**
2.	**Solve** parabolic, hyperbolic, and Burgers' equations using numerical methods.	**K3**
3.	**Model** incompressible and compressible flows using appropriate numerical formulations.	**K3**
4.	**Apply** the finite volume method to formulate two- and three-dimensional problems.	**K3**
5.	**Solve** linear steady and transient problems using finite element methods.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**INTRODUCTION:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations, Derivation of the Navier-Stokes equations. **SOLUTION METHODS:** Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.
UNIT-II (10 Hrs)	**PARABOLIC EQUATIONS:** Explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm. **HYPERBOLIC EQUATIONS:** Explicit schemes and Von Neumann stability analysis, implicit schemes, multi-step

	methods, nonlinear problems, second order one-dimensional wave equations. **BURGERS EQUATIONS:** Explicit and implicit schemes, Runge-Kutta method.
UNIT-III (10 Hrs)	**FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:** Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods. **FORMULATIONS OF COMPRESSIBLE FLOWS**: Potential equation, Euler equations-Central schemes, Navier-stokes system of equations, boundary conditions, example problems.
UNIT-IV (10 Hrs)	**FINITE VOLUME METHOD:** Finite volume method via finite difference method, formulations for two and three-dimensional problems.
UNIT-V (10 Hrs)	**FINITE ELEMENT METHODS:** Introduction to Finite Element Methods, Finite Element Interpolation Functions, Linear Problems-Steady-State Problems – Standard Galerkin's Methods, Transient Problems – Generalized Galerkin's Methods, Example Problems.

Textbooks:	
1.	Computational fluid dynamics, T. J. Chung, Cambridge University press, 2002.
2.	Introduction to Computational Fluid Dynamics, An: The Finite Volume Method" by H. Versteeg and W. Malalasekera.
Reference Books:	
1.	Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.
2.	Patankar, S. V., 2017, Numerical Heat Transfer and Fluid Flow, Special Indian ed., CRC Press.
3.	Muralidhar K., and Sundararajan T. (Editors), 2017, Computational Fluid Flow and Heat Transfer, 2nd ed. tenth reprint, Narosa.
4.	Anderson Jr., J. D., 2017, Computational Fluid Dynamics: The Basics with Applications, Indian ed., McGraw Hill Education.
5.	Donea, J., and Huerta, A., 2003, Finite Element Methods for Flow Problems, John Wiley & Sons, Ltd.
6.	Zienkiewicz, O. C, Nithiarasu, P., and Taylor, R. L, 2013, The Finite Element Method for Fluid Dynamics, 7th ed., Butterworth-Heinemann Ltd.
e-Resources	
1.	https://nptel.ac.in/courses/112/105/112105254/
2.	https://nptel.ac.in/courses/112/105/112105045/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3206	PE	3	--	--	3	30	70	3 Hrs.

ENERGY STORAGE TECHNOLOGIES

(For ME)

Course Objectives:

1.	Get the insights into importance of energy storage systems
2.	Understand the chemical and electromagnetic storage systems
3.	Know the principles of electrochemical storage systems
4.	Learn the working of supercapacitors and fuel cells
5.	Know how to design batteries for transportation

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

S.No	Outcome	Knowledge Level
1.	**Model** the scope and applications of energy storage technologies in power and transport sectors.	**K3**
2.	**Demonstrate** the concepts, applications, and future prospects of chemical and electromagnetic energy storage systems.	**K3**
3.	**Determine** the working principles and types of batteries.	**K3**
4.	**Demonstrate** the working principles and types of supercapacitors and fuel cells.	**K3**
5.	**Model** thermal management strategies and thermal runaway behavior.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**Energy storage systems overview** - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. Thermal storage system-heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems.
UNIT-II (10 Hrs)	**Chemical storage system**- hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems. **Electromagnetic storage systems** - double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems.

UNIT-III (10 Hrs)	**Electrochemical storage system** Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery.
UNIT-IV (10 Hrs)	**Super capacitors**- Working principle of super capacitor, types of super capacitors, cycling and performance characteristics, difference between battery and super capacitors, Introduction to Hybrid electrochemical super capacitors **Fuel cell-** Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-super capacitor systems.
UNIT-V (10 Hrs)	**Battery design for transportation**, Mechanical Design and Packaging of Battery, Packs for Electric Vehicles, Advanced Battery, Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal run-away for battery systems, Thermal management of battery systems, State of Charge and State of Health Estimation Over the Battery Lifespan, Recycling of Batteries from Electric Vehicles.
Textbooks:	
1.	Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
2.	Ralph Zito, Energy storage: A new approach, Wiley (2010)
Reference Books:	
1.	Pistoia, Gianfranco, and BoryannLiaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
2.	Robert A. Huggins, Energy storage, Springer Science & Business Media (2010**)**
e-Resources	
1.	https://nptel.ac.in/courses/113/105/113105102
2.	https://onlinecourses.nptel.ac.in/noc22_ch66/preview

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3208	PE	3	--	--	3	30	70	3 Hrs.

NON DESTRUCTIVE EVALUATION

(For ME)

Course Objectives:

1.	To learn basic concepts of non-destructive testing and radiographic test.
2.	To understand the elements of ultrasonic test and limitations of ultrasonic test.
3.	To learn the concepts involved in the liquid penetrant test and eddy current test.
4.	To know the basic principles and operating procedures of magnetic particle testing.
5.	To understand the basic concepts involved in the infrared and thermal testing.

Course Outcomes

S.No	Outcome	Knowledge Level
1	**Apply** NDT methods to distinguish dry and wet techniques and perform radiographic testing with safety.	K3
2	**Apply** ultrasonic testing procedures using wave principles and transducers to detect internal flaws.	K3
3	**Use** liquid penetrant and eddy current methods to identify surface and near-surface defects.	K3
4	**Demonstrate** magnetic particle testing by applying magnetization and interpreting results.	K3
5	**Apply** infrared and thermal testing techniques to detect heat variations using sensitive materials.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to non-destructive testing and industrial Applications of NDE:** Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions**.** **Radiographic Test:** Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography, neutron ray radiography.
UNIT-II (10 Hrs)	**Ultrasonic Test:** Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics. Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

UNIT-III (10 Hrs)	**Liquid Penetrant Test:** Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness, DPI, FPI,Limitations of Liquid Penetrant Testing. **Eddy Current Test:** Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing.
UNIT-IV (10 Hrs)	**Magnetic Particle Test:** Magnetic Materials, Magnetization of Materials Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test.
UNIT-V (10 Hrs)	**Infrared and Thermal Testing:** Introduction and fundamentals to infrared and thermal testing-Heat transfer -Active and passive techniques -Lock in and pulse thermography, tomography-Contact and non-contact thermal inspection methods-Heat sensitive paints -Heat sensitive papers thermally quenched phosphors liquid crystals -techniques for applying liquid crystals -other temperature sensitive coatings.
Textbooks:	
1.	Nondestructive test and evaluation of Materials by J Prasad, GCK Nair, MH Publishers.
2.	Ultrasonic testing of materials by H KrautKramer, Springer.
Reference Books:	
1.	Nondestructive testing by Warren, J Mc Gonnagle, Gordon & Breach Science publishers.
2.	Nondestructive evaluation of materials by infrared thermography by X. P. V Maldague, Springer-Verlag, 1% edition (1993).
3.	Ultrasonic inspection training for NDT by E.A. Gingel, Prometheus Press.
4.	ASTM Standards, Vol3.01, Metals and alloys.
5.	Non-Destructive Evaluation Hand Book by R. Ham Chand.
e-Resources	
1.	https://nptel.ac.in/courses/113106070
2.	https://www.udemy.com/course/non-destructive-testing-methods/?couponCode=CP130525

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3209	PE	3	--	--	3	30	70	3 Hrs.

RENEWABLE ENERGY TECHNOLOGIES

(For ME)

Course Objectives:

1.	To demonstrate the importance the impact of solar radiation.
2.	To understand the principles of storage in PV systems
3.	To discuss solar energy storage systems and their applications.
4.	To get knowledge in wind energy and bio-mass
5.	To gain insights in geothermal energy, ocean energy and fuel cells.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Demonstrate** the importance of solar radiation.	**K3**
2.	**Use** the principles of storage in PV systems.	**K3**
3.	**Determine** the solar energy storage for various applications.	**K3**
4.	**Apply** the fundamentals of wind energy and biomass energy..	**K3**
5.	**Apply** to learn about fuel cells, ocean energy, and geothermal energy.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**SOLAR RADIATION:** Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data
UNIT-II (10 Hrs)	**STORAGE IN PV SYSTEMS:** Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.
UNIT-III (10 Hrs)	**SOLAR ENERGY COLLECTION:** Flat plate and concentrating collectors, classification of concentrating collectors, orientation. **SOLAR ENERGY STORAGE AND APPLICATIONS:** Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.
UNIT-IV (10 Hrs)	**WIND ENERGY:** Sources and potentials, onshore and offshore wind energy, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

	BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.
UNIT-V (10 Hrs)	**GEOTHERMAL ENERGY:** Origin, Applications, Types of Geothermal Resources, Relative Merits **OCEAN ENERGY:** Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges **FUEL CELLS:** Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Textbooks:	
1.	Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
2.	Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006
Reference Books:	
1.	Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013
2.	Principles of Solar Engineering - D.YogiGoswami, Frank Krieth& John F Kreider / Taylor &Francis
3.	Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
4.	Renewable Energy Technologies -Ramesh & Kumar /Narosa
5.	Non-conventional Energy Source- G.D Roy/Standard Publishers
e-Resources	
1.	https://nptel.ac.in/courses/103103206
2.	https://nptel.ac.in/courses/103107157

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3210	PE	3	--	--	3	30	70	3 Hrs.

FINITE ELEMENT METHODS

(For ME)

Course Objectives:

1.	To understand the Fundamental Principles and Mathematical Foundations of Finite Element Methods.
2.	To teach students how to perform structural analysis using finite element methods.

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

S.No.	Outcome	Knowledge Level
1.	Understand the fundamental concepts of finite element methods and **solve** the physical problem using functional approximation method.	K3
2.	**Analyze** the 1Dstructural problems by applying the concepts of finite element methods.	K4
3.	**Analyze** trusses and beams by applying the concepts of finite element methods.	K4
4.	**Analyze** 2D structural problems by applying concepts of finite element methods and apply the principles of Numerical Integration and its application to finite element methods.	K4
5.	**Analyze** Axisymmetric solids and dynamic behavior of structure by applying the concepts of Finite Element methods	K4

SYLLABUS

UNIT-I (8 Hrs)	Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one-dimensional problems.
UNIT-II (8Hrs)	One Dimensional Bar Problems: 1-D bar element - shape functions – Stiffness matrix and load vector– assembly of Matrices – Treatment of boundary conditions One dimensional quadratic element – Temperature Effects.
UNIT-III (10 Hrs)	Trusses: Introduction; Plane trusses; shape functions – Stiffness matrix and load vector– assembly of Matrices – Treatment of boundary conditions, simple problems on trusses. Analysis of Beams: Beam Element - Shape functions and Element stiffness matrix, load vector for concentrated and Uniformly Distributed Load, simple problems on beams.

UNIT-IV (8Hrs)	Two Dimensional Problems: Finite element modeling of two-dimensional Problems - constant strain triangle Element - treatment of boundary conditions 2D four nodediso parametric element, numerical integration, Gaussian Quadrature Approach.
UNIT-V (10 Hrs)	Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling - triangular element, Problem modeling and boundary conditions. Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

Textbooks:	
1.	Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall.
2.	The Finite Element Methods in Engineering, S.S.Rao, Pergamon.
Reference Books:	
1.	The Finite Element Method by O.C. Zienkiewicz, Tata McGraw Hill Company Ltd.
2.	Finite Element Method with applications in Engineering, YM Desai, Eldho& Shah, Pearson Publishers.
3.	An Introduction to Finite Element Method, JNReddy, McGraw-Hill.
4.	The Finite Element Method for Engineers, Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and TedG. Byrom, John Wiley &Sons (ASIA) Pvt Ltd.
5.	Finite Element Analysis: Theory and Application with ANSYS, Saeed Moaveni, Pearson Education.
e-Resources	
1.	https://nptel.ac.in/courses/112104193
2.	https://nptel.ac.in/courses/112104116
3.	https://nptel.ac.in/courses/112104205

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3211	PE	3	--	--	3	30	70	3 Hrs.

REFRIGERATION & AIR-CONDITIONING

(For ME)

Course Objectives:

1.	To use operational cycles to demonstrate different refrigeration systems.
2.	To determine cooling capacity and coefficient of performance of vapour compression refrigeration systems.
3.	To calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration system and understand the properties refrigerants.
4.	To calculate cooling load for air conditioning systems and identify the requirements of comfort air conditioning
5.	To demonstrate different component of refrigeration and air conditioning systems

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Demonstrate** different refrigeration systems using operational cycles	**K3**
2.	**Compute** cooling capacity and coefficient of performance of vapour compression refrigeration systems	**K3**
3.	**Determine** the coefficient of performance by evaluating steam jet refrigeration and vapor absorption systems.	**K3**
4.	**Calculate** cooling load for air conditioning systems and identify the requirements of comfort air conditioning.	**K3**
5.	**Demonstrate** different components of refrigeration and air conditioning systems.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**INTRODUCTION TO REFRIGERATION:** Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: Bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts.
UNIT-II (10 Hrs)	**VAPOUR COMPRESSION REFRIGERATION SYSTEM &COMPONENTS**: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.
UNIT-III (10 Hrs)	**REFRIGERANTS–** Desirable properties – classification - refrigerants –green refrigerants- nomenclature – ozone depletion – global warming. **VAPOR ABSORPTION SYSTEM:** Calculation of maximum COP – description and

	working of NH3 – water system and Li Br –water (Two shell & Four shell) System, principle of operation three fluid absorption system, salient features. **STEAM JET REFRIGERATION SYSTEM:** Working Principle and basic components, principle and operation of thermoelectric refrigerator and vortex tube.
UNIT-IV (10 Hrs)	**INTRODUCTION TO AIR CONDITIONING:** Psychometric properties & processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF- problems, concept of ESHF and ADP temperature. Requirements of human comfort and concept of effective temperature- comfort chart
UNIT-V (10 Hrs)	**AIR CONDITIONING SYSTEMS:** Classification of equipment's, Comfort air conditioning – requirements of industrial air conditioning, air conditioning load calculations. cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. **INTRODUCTION TO CRYOGENICS:** Joule-Thomson expansion, refrigerant mixtures**,** multi stage vapour compression refrigeration.

Textbooks:	
1.	A Course in Refrigeration and Air conditioning / SC Arora &Domkundwar / Dhanpatrai
2.	Refrigeration and Air Conditioning / CP Arora / TMH.
3.	Fundamentals of Cryogenic Engineering" by Mukhopadhyay / PHI Learning
Reference Books:	
1.	Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2.	Principles of Refrigeration /Dossat / Pearson Education.
3.	Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH
e-Resources	
1.	https://nptel.ac.in/courses/112107208
2.	https://archive.nptel.ac.in/courses/112/105/112105128/

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23ME3213	PC	--	-	3	1.5	30	70	3hrs

HEAT TRANSFER LAB

(For ME)

Course Objectives:

1.	This course is designed to introduce a basic study, the phenomena of heat and mass transfer, and to provide useful information concerning the performance and design of particular systems and processes.
2.	A knowledge-based design problem requiring the formulations of solid conduction and fluid convection and the technique of numerical computation.
3.	Examine the basic concepts of heat transfer models –thermal gradients, conduction, convection, and radiation.
4.	To help the student develop skills that would apply to life long learning.

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

S.No.	Outcome	Knowledge Level
1.	**Analyze** the heat transfer by conduction, convection, and radiation; collect data; perform analyses; and interpret the results to draw valid conclusions using standard testing procedures.	K4
2.	**Categorize** the thermal properties and performance of heat exchanger	K4

SYLLABUS

LIST OF EXPERIMENTS

1.	Determination of Thermal Conductivity for a Given Copper MetalRod.
2.	Determination of Thermal Conductivity for a Composite Wall.
3.	Determination of Heat Transfer through Pin-Fin.
4.	Determination of Heat Transfer through Forced Convection.
5.	Determination of Heat Transfer through Natural Convection.
6.	Determination of overall heat transfer coefficient for Parallel and Counter Flow Heat Exchanger.
7.	Measure the Emissivity of given test surface.
8.	Measurement of Stefan Boltzmann constant.
9.	Determination of Heat Transfer through Drop Wise and Film Wise Condensation.
10.	Determination of Two phase heat Transfer.
11.	Study of Refrigeration and Air Conditioning TestRig.

ReferenceBooks:

1.	YunusA. Cengel, “Heat Transfer a Practical Approach”, Tata McGraw-Hill Education.
2.	R.C.Sachdeva, “Fundamentals of Engineering, Heat and Mass Transfer”, NewAge publication.
3.	Heat & Mass Transfer by P.K.Nag,McGrawHill.

e- Resources

1.	Virtual labs (https://mfts-iitg.vlabs.sc.in/)

Course Code	Category	L	T	P	C	C.I.E	S.E.E	Exam
B23ME3214	PC	--	--	3	1.5	30	70	3 Hrs.

INDUSTRIAL ENGINEERING LAB

(For ME)

Course Objectives:

1	To make students acquainted with the different control charts and probability distribution curves
2	To make students aware with the different types of process charts for improving method of doing work
3	To make students learn the impact of work on human physiology and physiological constraints of body

Course Outcomes:

S.No	Outcome	Knowledge Level
1	**Analyze** Shewart Normal Bowl theory.	**K4**
2	**Analyze** the process and product quality by Statistical Quantity Control Techniques.	**K4**
3	**Apply** work study techniques for man- machine and work place activities to improve productivity.	**K3**

SYLLABUS

1	To show that the sample means from a normal universe follow a normal distribution
2	To show that the sample means from a non-normal universe follow a rectangular distribution
3	To draw the control chart for mean and range for the measurements of output of a manufacturing process and to study its process capability and write a Python program to draw the control chart.
4	To draw the control chart for the fraction defective for a given lot of marble balls for the constant sample size, and write a Python program to draw the control chart.
5	To draw the control chart for the fraction defective for a given lot of marble balls for the variable sample size, and write a Python program to draw the control chart.
6	To draw the control chart for defects observed on a given lot of steel discs, and write a Python program to draw the control chart.
7	To conduct Single Sampling Plan on a given lot of marbles, and hence to draw its Operating Characteristic curve. Also write a Python program to draw the Operating Characteristic curve.
8	To draw two handed process charts for Bolt, Washer and nut assembly (Present and Improved methods)
9	To draw Multiple Activity chart using an electric toaster.
10	To measure the skill and dexterity in the movement of Wrist and Fingers using pin board and to estimate the standard time for the best method of performance.
11	To measure the Heart rate during working and recovery periods of the subjects under different loads, using Bicycle Ergometer

Reference Books:

1.	Industrial Engineering and Management by Dr. O.P. Khanna
2.	Industrial Engineering and Production Management by Telsay, S.Chand& Co

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3214	PC	--	--	2	1	30	70	3Hrs.

THEORY OFMACHINES LAB

(For ME)

Course Objectives:

1	To demonstrate the motion of a gyroscope and characteristics of governors.
2	To find the frequencies of damped and undamped free and forced vibrations
3	To analyze different mechanisms

Course Outcomes:

S.No	Outcome	Knowledge Level
1	**Demonstrate** the motion of a gyroscope.	**K3**
2	**Demonstrate** the characteristics of governors.	**K3**
3	**Determine**thefrequenciesofdampedandundampedfreeandforcedvibrations.	**K3**
4	**Analyze** different mechanisms.	**K4**
5	**Demonstrate** various types of gears.	**K3**

SYLLABUS

1	To determine whirling speed of shaft theoretically and experimentally
2	To determine the position of sleeve against controlling force and speed of a governor and to plot the characteristic curve of radius of rotation.
3	To analyse the motion of a motorized gyroscope when the couple is applied along its spin
4	To determine the frequency of undamped free vibration of an equivalent spring mass system.
5	To determine the frequency of damped force vibration of a spring mass system
6	To study the static and dynamic balancing using rigid blocks.
7	To plot follower displacement vs cam rotation for various Cam Follower systems.
8	To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/ Four bar mechanism
9	To find the coefficient of friction between the belt and pulley.
10	To study simple and compound screw jack and determine the mechanical advantage, velocity ratio, and efficiency
11	To Analyze the velocity and time ratios of a cutting tool in Whitworth quick return motion mechanisms.
12	To study various types of gears-Spur, Helical, Worm and Bevel Gears

Reference Books:

1	The Theory of Machines by Thomas Bevan, CSB publisher and distributors.
2	Theory of Machines by SSRatan, McGraw Hill Education.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME3215	ES	-	--	2	1	30	70	3 Hrs.

TINKERING LAB

(For ME)

Course Objectives: To

1.	Encourage Innovation and Creativity
2.	Provide Hands-on Learning
3.	Impart Skill Development
4.	Foster Collaboration and Teamwork
5.	Enable Interdisciplinary Learning
6.	Impart Problem-Solving mind-set
7.	Prepare for Industry and Entrepreneurship

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

S.No	Outcome	Knowledge Level
1	**Demonstrate** their ability in building prototypes.	K3
2	**Analyze** a societal problem, develop a solution and transform the solution into a product.	K4
3	**Demonstrate** their ability in team work, Interdisciplinary Learning and problem solving mind set.	K3

List of Experiments

1	Make your own parallel and series circuits using breadboard for any application of your choice.
2	Demonstrate a traffic light circuit using breadboard.
3	Build and demonstrate automatic Street Light using LDR.
4	Simulate the use of four DC motors using a motor driver
5	Build and demonstrate a 4WD car using Arduino.
6	Interfacing IR Sensor and Servo Motor with Arduino.
7	Blink LED using ESP32.
8	LDR Interfacing with ESP32.
9	Control a 4WD car using Mobile app
10	Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote plan in
11	Design and 3D print a Walking Robot
12	Design and 3D Print a Drone.

Text Books:

1. Embedded Systems Architecture by Tammy Noergaard, Elsevier Publications, 2013.
2. Embedded Systems by Shibu K V, Tata McGraw Hill Education Private Limited,2013.
3. Embedded Systems, Lyla B Das, Pearson Publications, 2013.
4. Internet of Things- A Hands on Approach, ArshdeepBahga& Vijay Madisetti, Orient Blackswan Private Limited, New Delhi,2015.
5. 3D printing and design by Dr. S. Soloman, Khanna Publications,2020.

e-Resources:

1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AC3201	SEC	--	1	2	2	30	70	3Hrs.

SOFT SKILLS

(For AIML, CSBS, CSE, IT and MECH)

Course Objectives:

1	To familiarise students with soft skills and how they influence their professional growth.
2	To build/refine the professional qualities/skills necessary for a productive career and to instill confidence through attitude building.

Course Outcomes:

S. No	Outcome	Knowledge Level
1	Interpret the essence of key soft skills such as creativity & problem solving, emotional intelligence, leadership qualities, etc.	K2
2	Outline interview essentials for graduate-job prospects.	K2
3	Apply presentation skills in academic and professional settings.	K3
4	Demonstrate knowledge about domain specific industry and the prospective workplace.	K2

SYLLABUS

1	**INTRODUCTION** Introduction to soft skills, definition and meaning, importance and need in personal and professional settings; soft skills vs. hard skills; personality development.
2	**INTRA-PERSONAL AND INTER-PERSONAL COMMUNICATION** Significance of Inter & Intra-Personal Communication; SWOT Analysis; Goal Setting – Guidelines for Goal Setting; Emotional Intelligence; Creativity & Problem Solving; Stress and Time Management; Leadership & Team Work; Building a positive attitude, Social Consciousness.
3	**WRITTEN COMMUNICATION** Resume Preparation: Common resume blunders, Tips for betterment, Resume Review; Report Writing; Writing an SOP (Statement of purpose).
4	**PRESENTATION SKILLS** Importance of Presentation Skills; JAM; Essential guidelines for Group Discussions; Debates; Role Plays; PPTs etc.
5	**INTERVIEW SKILLS** Employability Skills: Knowing about Selection Process; Interview Skills, types of Interviews, E-Interviews, Do's and Don'ts of Interviews, FAQs, Mock Interviews; Awareness about Industries; Importance of researching the prospective workplace.

Text Books:

1	Sherfield, M. Robert et al, Cornerstone Developing Soft Skills,(4th edition), Pearson Publication, New Delhi, 2014.
2	Alka Wadkar, Life Skills for Success,(1st edition), Sage Publications India Private Limited, 2016.
3	Soft Skills : Know Yourself and Know the World by Dr. K. Alex, S. Chand & Company Ltd., New Delhi, 2009.

Reference Books:

1	Sambaiah.M. Technical English, Wiley Publishers India. New Delhi. 2014.
2	Gangadhar Joshi, From Campus to Corporate, SAGE TEXT, 2015.

3	Alex.K, Soft Skills, 3rd ed. S. Chand Publication, New Delhi, 2014.
4	Meenakshi Raman and Sangeeta Sharma, Technical Communication: Principle and Practice, Oxford University Press, 2009.
5	Emotional Intelligence by Daniel Goleman, Random House Publishing Group, 2012.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AC3201	AC	2	--	--	--	30	--	3 Hrs.

TECHNICAL PAPER WRITING & IPR

(Common to AI&DS, CSE, AIML, CSIT, IT, CSD, CSBS, CIC, CE, ME)

Course Objectives:

1.	To appreciate the difference in English used in Academic, Business, Legal and other contexts.
2.	To know the fundamentals of basic technical report structure and writing.
3.	To understand the filing and processing of patent application.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Construct grammatically sound and concise technical write-ups.	K3
2.	Prepare the outline and structure of a technical paper with essential sections.	K3
3.	Develop a project proposal and dissertation framework aligned with academic conventions.	K3
4.	Use a word processor effectively for document formatting, citations, and version control.	K3
5.	Identify appropriate IPR mechanisms for protecting various types of intellectual creations.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** An introduction to writing technical reports, technical sentences formation, using transitions to join sentences, Using tenses for technical writing. Planning and Structuring: Planning the report, identifying reader(s), Voice, Formatting and structuring the report, Sections of a technical report, Minutes of meeting writing.
UNIT-II (10 Hrs)	**Drafting report and design issues**: The use of drafts, Illustrations and graphics. Final edits: Grammar, spelling, readability and writing in plain English: Writing in plain English, Jargon and final layout issues, Spelling, punctuation and Grammar, Padding, Paragraphs, Ambiguity.
UNIT-III (10 Hrs)	**Proofreading and summaries:** Proofreading, summaries, Activities on summaries. Presenting final reports: Printed presentation, Verbal presentation skills, Introduction to proposals and practice.
UNIT-IV (10 Hrs)	**Using word processor:** Adding a Table of Contents, Updating the Table of Contents, Deleting the Table of Contents, Adding an Index, Creating an Outline, Adding Comments, Tracking Changes, Viewing Changes, Additions, and Comments, Accepting and Rejecting Changes, Working with Footnotes and Endnotes, Inserting citations and Bibliography, Comparing Documents, Combining Documents, Mark documents final and make them read only., Password protect Microsoft Word documents., Using Macros

UNIT-V (10 Hrs)	**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of **Patenting and Development:** technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property
Textbooks:	
1.	Kompal Bansal &Parshit Bansal, "Fundamentals of IPR for Beginner's", 1st Ed., BS Publications, 2016.
2.	William S. Pfeiffer and Kaye A. Adkins, "Technical Communication: A Practical Approach", Pearson.
Reference Books:	
1.	Ramappa,T., "Intellectual Property Rights Under WTO", 2nd Ed., S Chand, 2015.
2.	Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.
3.	Day R, How to Write and Publish a Scientific Paper, Cambridge University Press(2006)
e-Resources	
1.	https://www.udemy.com/course/reportwriting/
2.	https://www.udemy.com/course/professional-business-english-and-technical-report-writing/
3.	https://www.udemy.com/course/betterbusinesswriting/