JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE

For UG – R20

B. TECH - MECHANICAL ENGINEERING

(Applicable for batches admitted from 2020-2021)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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III B.TECH I SEMESTER

S No	Code	Course Title	Hours			Credits
			L	T	P	
1	PCC-7	Thermal Engineering-II	3	0	0	3
2	PCC-8	Design of Machine Members-I	3	0	0	3
3	PCC-9	Machining, Machine Tools & Metrology	3	0	0	3
4	OE-1	1. Sustainable Energy Technologies 2. Operations Research 3. Nano Technology 4. Thermal Management of Electronic systems	3	0	0	3
5	PE-1	1. Finite Element Methods 2. Industrial Robotics 3. Advanced Materials 4. Renewable Energy Sources 5. Mechanics of Composites 6. MOOCs (NPTEL/ Swayam) Course (12 Week duration)	3	0	0	3
6	PCC-L6	Machine Tools Lab	0	0	3	1.5
7	PCC-L7	Thermal Engineering Lab	0	0	3	1.5
8	SOC-3	Advanced Communication Skills Lab	1	0	2	2
9	MC – 4	Professional Ethics and Human Values	2	0	0	0
Evaluation of Summer Internship which is completed at the end of II B.Tech II Semester						1.5
					Total credits	**21.5**
Honors/Minor courses			**4**	**0**	**0**	**4**

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DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECTS FOR B. Tech. (MINOR) in MECHANICAL ENGINEERING

B. Tech. (MINOR) in MECHANICAL ENGINEERING		**Pre-requisites**
1.	Basic Thermodynamics	NIL
2.	Manufacturing Processes	NIL
3.	Materials Science and Engineering	NIL
4.	Basic Mechanical Design	NIL
5.	Optimization Techniques	NIL
6.	Power Plant Engineering	Basic Thermodynamics
7.	Automobile Engineering	Basic Thermodynamics
8.	Industrial Engineering and Management	NIL
9.	Product Design & Development	NIL
10.	Smart Manufacturing	NIL
11.	Mechanical Measurements	NIL
12.	Industrial Robotics	Engineering Mechanics
13.	Mechatronics	NIL

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SUBJECTS FOR B. Tech. (HONORS) IN MECHANICAL ENGINEERING

HONORS IN MECHANICAL ENGINEERING		Pre-requisites
POOL – 1 (in II-II)		
1.	Advanced Mechanics of Fluids	Fluid Mechanics
2.	Green Manufacturing	Production Technology
3.	Analysis and Synthesis of Mechanisms	Kinematics of Machinery
4.	Alternative Fuels Technologies	Basic Thermodynamics
5.	Gear Engineering	Kinematics of Machinery
POOL-2 (in III-I)		
1.	Experimental Methods in Fluid Mechanics	Fluid Mechanics
2.	Advanced Optimization Techniques	Operations Research
3.	Micro Electro Mechanical Systems	Nil
4.	Tribology	Nil
5.	Statistical Design in Quality Control	Nil
POOL-3 (in III-II)		
1.	Advanced Computational Fluid Dynamics	Fluid Mechanics
2.	Material Characterization Techniques	Material Science and Metallurgy
3.	Product Design	Nil
4.	Electric & Hybrid Vehicles	Thermal Engineering
5.	Mechanical Vibrations & Acoustics	Nil
POOL-4 (in IV-I)		
1.	Advanced Thermodynamics	Nil
2.	Design for Manufacturing and Assembly	Production Technology
3.	Robotics and Control	Kinematics of Machinery
4.	Turbo Machines	FM&HM
5.	Materials Technology	Nil

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III Year-I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

THERMAL ENGINEERING – II

(Use of steam tables and Mollier chart is allowed)

Course objectives*:*

1) To understand the basic concepts of thermal engineering and boilers.
2) To gain knowledge about the concepts of steam nozzles and steam turbines.
3) To gain knowledge about the concepts of reaction turbine and steam condensers.
4) To understand the concepts of reciprocating and rotary type of compressors.
5) To acquire knowledge about the centrifugal and axial flow compressors.

UNIT– I:

BASIC CONCEPTS: Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating. combustion: fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, Stoichiometry, flue gas analysis.

BOILERS : Classification – working principles of L.P & H.P boilers with sketches – mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – Draught: classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced.

UNIT– II:

STEAM NOZZLES: Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow - its effects, degree of super saturation and degree of under cooling, Wilson line.

STEAM TURBINES: Classification – impulse turbine; mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-laval turbine - methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, velocity and pressure variation along the flow – combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency.

UNIT– III:

REACTION TURBINE: Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height.

STEAM CONDENSERS: Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects, air pump, cooling water requirement.

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UNIT– IV:
COMPRESSORS: Classification – fan, blower and compressor – positive displacement and non-positive displacement type – reciprocating and rotary types.
RECIPROCATING: Principle of operation, work required, Isothermal efficiency, volumetric efficiency and effect of clearance, multi stage compression, saving of work, minimum work condition for two stage compression.
ROTARY: Roots Blower, vane sealed compressor, Lysholm compressor –mechanical details and principle of working – efficiency considerations.

UNIT– V:
CENTRIFUGAL COMPRESSORS: Mechanical details and principle of operation –velocity and pressure variation. Energy transfer-impeller blade shape-losses,slip factor, power input factor, pressure coefficient and adiabatic coefficient– velocity diagrams – power.
AXIAL FLOW COMPRESSORS: Mechanical details and principle of operation – velocity triangles and energy transfer per stage degree of reaction, work done factor – isentropic efficiency- pressure rise calculations – Poly tropic efficiency.

TEXT BOOKS:
1) Thermodynamics and Heat Engines/R.Yadav, Volume -II /Central Publishing House
2) Heat Engineering /V.P Vasandani and D.S Kumar/Metropolitan Book Company, New Delhi.

REFERENCES:
1) Thermal Engineering-M.L.Mathur & Mehta/Jain bros. Publishers
2) Thermal Engineering-P.L.Ballaney/ Khanna publishers.
3) Thermal Engineering / RK Rajput/ Lakshmi Publications
4) Thermal Engineering-R.S Khurmi, &J S Gupta/S.Chand.

Course Outcomes: At the end of the course, student will be able to
CO1: Explain the basic concepts of thermal engineering and boilers.
CO2: Discuss the concepts of steam nozzles and steam turbines.
CO3: Gain knowledge about the concepts of reaction turbine and steam condensers.
CO4: Discuss the concepts of reciprocating and rotary type of compressors.
CO5: Acquire knowledge about the centrifugal and axial flow compressors.

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III Year-I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
DESIGN OF MACHINE MEMBERS-I					

Course objectives:
1) To understand the materials and their properties along with manufacturing considerations.
2) To gain knowledge about the strength of machine elements.
3) To understand and apply the knowledge in designing the riveted and welded joints, keys, cotters and knuckle joints.
4) To understand and apply the knowledge in designing the shafts and shaft couplings.
5) To understand and apply the knowledge in designing the mechanical springs.

UNIT– I:
INTRODUCTION: General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design, tolerances and fits –BIS codes of steels- ASHBY Charts.
STRESSES IN MACHINE MEMBERS: Simple stresses – combined stresses – torsional and bending stresses – impact stresses – stress strain relation – various theories of failure – factor of safety – design for strength and rigidity – preferred numbers-concept of stiffness in tension, bending, torsion and combined situations – static strength design based on fracture toughness.

UNIT– II:
STRENGTH OF MACHINE ELEMENTS: Stress concentration – theoretical stress concentration factor – fatigue stress concentration factor notch sensitivity – design for fluctuating stresses – endurance limit – estimation of endurance strength – Goodman's line – Soderberg's line – modified goodman's line

UNIT– III:
RIVETED AND WELDED JOINTS – design of joints with initial stresses – eccentric loading.
Bolted joints – design of bolts with pre-stresses – design of joints under eccentric loading – locking devices – both of uniform strength, different seals.
KEYS, COTTERS AND KNUCKLE JOINTS: Design of keys-stresses in keys-cotter joints-spigot and socket-sleeve and cotter-jib and cotter joints- knuckle joints.

UNIT– IV:
SHAFTS: Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads – shaft sizes – BIS code- Use of internal and external circlips- gaskets and seals (stationary & rotary).
SHAFT COUPLING: Rigid couplings – muff, split muff and flange couplings, flexible couplings – flange coupling (modified).

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UNIT– V: DEPARTMENT OF MECHANICAL ENGINEERING

MECHANICAL SPRINGS:

Stresses and deflections of helical springs – extension -compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – co-axial springs, leaf springs.

Note: Design data book is NOT Permitted in the examination

TEXT BOOKS:

1. Machine design / NC Pandya & CS Shah/Charotar Publishing House Pvt. Limited
2. Machine Design/V.B.Bhandari/ McGraw-Hill Education

REFERENCES:

1. Design of Machine Elements / V.M. Faires/McMillan
2. Machine design / Schaum Series/McGraw-Hill Professional
3. Machine Design/ Shigley, J.E/McGraw Hill.
4. Design data handbook/ K.Mahadevan & K. Balaveera Reddy/ CBS publishers.
5. Machine Design –Norton/ Pearson publishers

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

CO1: Judge about materials and their properties along with manufacturing considerations.
CO2: Gain knowledge about the strength of machine elements.
CO3: Apply the knowledge in designing the riveted and welded joints, keys, cotters and knuckle joints.
CO4: Apply the knowledge in designing the shafts and shaft couplings.
CO5: Apply the knowledge in designing the mechanical springs.

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III Year-I Semester		L	T	P	C
		3	0	0	3
MACHINING, MACHINE TOOLS & METROLOGY					

Course objectives:
1) To gain fundamental knowledge of machining processes.
2) To understand the principles of lathe, shaping, slotting and planning machines.
3) To demonstrate the principles of drilling, milling and boring processes.
4) To understand the concepts of finishing processes and the system of limits and fits.
5) To gain knowledge about the concepts of surface roughness and optical measuring instruments.

UNIT– I:
FUNDAMENTAL OF MACHINING:
Elementary treatment of metal cutting theory – element of cutting process – Single point cutting tools, nomenclature of single point cutting tool, tool signature, tool angles, mechanism of metal cutting, types of chips and chip formation – built up edge and its effects, chip breakers, mechanics of orthogonal and oblique cutting –Merchant's force diagram, cutting forces, velocity ratio, cutting speeds, feed, depth of cut, tool life, Taylor's tool life equation, simple problems - Tool wear, tool wear mechanisms, machinability, economics of machining, coolants, tool materials and properties.

UNIT– II:
LATHE MACHINES:
Introduction- types of lathe - Engine lathe – principle of working - construction - specification of lathe - work holders and tool holders – accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes – cutting speed and feed-depth of cut.
SHAPING, SLOTTING AND PLANNING MACHINES: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism - machining time calculations.

UNIT– III:
DRILLING & BORING MACHINES: Introduction – construction of drilling machines – types of drilling machines - principles of working – specifications- types of drills – geometry of twist drill - operations performed –cutting speed and feed – machining time calculations - Boring Machines – fine Boring Machines – jig boring machines - deep hole Drilling Machines.
MILLING MACHINES: Introduction - principle of working – specifications – milling methods - classification of Milling Machines –types of cutters - geometry of milling cutters – methods of indexing, accessories to milling machines - cutting speed and feed – machining time calculations

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UNIT– IV:

FINISHING PROCESSES: Introduction - theory of grinding – classification of grinding machines- cylindrical and surface grinding machines- tool and cutter grinding machines- different types of abrasives- bonds, specification and selection of a grinding wheel-lapping, Honing & Broaching operations- comparison to grinding.

SYSTEMS OF LIMITS AND FITS: Introduction, nominal size, tolerance, limits, deviations, different types of fits -Unilateral and bilateral tolerance system, hole and shaft basis systems-interchangeability, deterministic & statistical tolerances, selective assembly- International standard system of tolerances, selection of limits and tolerances for correct functioning, simple problems related to limits and fits, Taylor's principle – design of go and no go gauges; plug, ring, snap, gap, taper, profile and position gauges – inspection of gauges.

UNIT– V:

SURFACE ROUGHNESS MEASUREMENT: Differences between surface roughness and surface waviness –Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, simple problems - method of measurement of surface finish – Profilograph, Talysurf, ISI symbols for indication of surface finish.

OPTICAL MEASURING INSTRUMENTS: Tools maker's microscope, Autocollimators, Optical projector, Optical flats-working principle, construction, merits, demerits and their uses. optical comparators.

TEXT BOOKS:

1) Manufacturing Processes / JP Kaushish/ PHI Publishers-2nd Edition
2) Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill
3) Engineering Metrology – R.K. Jain/Khanna Publishers

REFERENCES:

1) Metal cutting and machine tools /Geoffrey Boothroyd, Winston A.Knight/ Taylor & Francis
2) Production Technology / H.M.T. Hand Book (Hindustan Machine Tools).
3) Production Engineering/K.C Jain & A.K Chitaley/PHI Publishers
4) Technology of machine tools/S.F.Krar, A.R. Gill, Peter SMID/ TMH
5) Manufacturing Processes for Engineering Materials-Kalpak Jian S & Steven R Schmid/Pearson Publications 5th Edition

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

CO1: Discuss the concepts of machining processes.
CO2: Apply the principles of lathe, shaping, slotting and planning machines.
CO3: Apply the principles of drilling, milling and boring processes.
CO4: Analyze the concepts of finishing processes and the system of limits and fits.
CO5: Learn the concepts of surface roughness and optical measuring instruments.

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III Year-I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

SUSTAINABLE ENERGY TECHNOLOGIES (OE-1)

Course objectives:

1) To demonstrate the importance of solar energy collection and storage.
2) To understand the principles of wind energy and biomass energy.
3) To gain knowledge on geothermal and ocean energy.
4) To acquire knowledge about energy efficient systems.
5) To understand the concepts of green manufacturing systems.

UNIT– I:

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, numerical problems. Photo voltaic energy conversion – types of PV cells.

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– II:

WIND ENERGY: Sources and potentials, 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– III:

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy.

OCEAN ENERGY: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques.

UNIT– IV:

ENERGY EFFICIENT SYSTEMS:

(A) **ELECTRICAL SYSTEMS**: Energy efficient motors, energy efficient lighting and control, selection of luminaries, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

(**B) MECHANICAL SYSTEMS**: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps**.**

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UNIT– V:

GREEN MANUFACTURING SYSTEMS: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmental friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

TEXT BOOKS:

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.
3) Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013.

REFERENCES:

1) Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New Age International.
2) Principles of Solar Engineering - D.Yogi Goswami, 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.
6) Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd.
7) Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd.

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

CO1: Explain the importance of solar energy collection and storage.
CO2: Apply the principles of wind energy and biomass energy.
CO3: Analyze knowledge on geothermal and ocean energy.
CO4: Justify the knowledge about energy efficient systems.
CO5: Discuss the concepts of green manufacturing systems.

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III Year-I Semester		L	T	P	C
		3	0	0	3
OPERATIONS RESEARCH (OE-1)					

Course objectives:

1) To understand the basics of operations research, applications and linear programming problems.
2) To understand and apply the knowledge in solving problems of transportation, assignment and sequencing.
3) To understand the replacement and game theories and apply the knowledge to solve problems.
4) To gain knowledge about the waiting line models and project management techniques.
5) To understand and apply the knowledge in solving problems of dynamic programming and simulation.

UNIT– I:

INTRODUCTION - definition– characteristics and phases – types of operation research models – applications.

LINEAR PROGRAMMING: Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT– II:

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

SEQUENCING – Introduction – flow –shop sequencing – *n* jobs through two machines – *n* jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT– III:

REPLACEMENT THEORY: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

GAME THEORY: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

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UNIT– IV:
WAITING LINES: Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel.
PROJECT MANAGEMENT: Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

UNIT– V:
DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.
SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages.

TEXT BOOKS:
1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd.

REFERENCES:
1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan & Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K.Sharma/Macmillan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

Course Outcomes: At the end of the course, student will be able to
CO1: Apply the basics of operations research and linear programming problems.
CO2: Apply the knowledge in solving problems of transportation, assignment and sequencing.
CO3: Judge the replacement and game theories and apply the knowledge to solve problems.
CO4: Discuss the waiting line models and project management techniques.
CO5: Apply the knowledge in solving problems of dynamic programming and simulation.

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III Year-I Semester		L	T	P	C
		3	0	0	3
NANO TECHNOLOGY (OE-1)					

Course objectives:

1) To understand the nano-structured materials and their applications.
2) To gain knowledge about the nano crystalline materials, their properties and defects.
3) To understand various techniques of nanofabrication.
4) To identify the tools to characterize nano materials.
5) To analyze the applications of nano materials.

UNIT– I:
INTRODUCTION: History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, and applications of nano-materials, challenges and future prospects.

UNIT– II:
UNIQUE PROPERTIES OF NANO MATERIALS: Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and declinations. Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

UNIT– III:
SYNTHESIS ROUTES: Bottom up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly. Top down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot iso-static pressing and Cold iso-static pressing, Spark plasma sintering.

UNIT– IV:
TOOLS TO CHARACTERIZE NANOMATERIALS: X-Ray Diffraction (XRD), Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP),Nano indentation

UNIT– V:
APPLICATIONS OF NANO MATERIALS: Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS),Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water-Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology.

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TEXT BOOKS:

1) Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens.Wiley India Pvt. Ltd.
2) Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
3) Nano Essentials- T.Pradeep/TMH.

REFERENCE BOOKS:

1. Solid State physics by Pillai, Wiley Eastern Ltd.
2. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

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

CO1: Explain about nano-structured materials and their applications.
CO2: Apply knowledge about the nano crystalline materials, their properties and defects.
CO3: Justify various techniques of nanofabrication.
CO4: Apply the tools to characterize nano materials.
CO5: Analyze the applications of nano materials.

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III Year - I Semester		L	T	P	C
		3	0	0	3
THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS (OE-1)					

Course objectives:
1) To understand the basics of heat transfer and analyze heat transfer through fins
2) To understand the basics of convection and radiation modes of heat transfer.
3) To gain knowledge about the thermal analysis of printed circuit boards and their cooling.
4) To understand the principles of two-phase cooling and heat pipes.
5) To gain knowledge about the thermoelectric coolers.

UNIT– I:
Introduction of Heat Transfer and Conduction: Modes – Conduction, Convection and Radiation – Basic Laws – Applications of Heat Transfer
Basics of Conduction –Conduction equation – Thermal analogy – Lumped heat capacity analysis - Heat conduction with phase change - Thermal Resistance – Extended Surfaces – Uniform cross section fins – Fin efficiency – Selection and design of fins.

UNIT– II:
Convection and Radiation: Forced and Free Convection – Heat transfer coefficient - Parameters effecting heat transfer – Thermal Properties of fluids - Combined Modes
Radiation – Stefan- Boltzmann Law – Kirchoff's law and Emissivity – Radiation between Black Isothermal Surfaces – Radiation between Grey Isothermal Surfaces – Extreme Climatic conditions - Radiation at normal ambient. Temperature measurement and its Instrumentation.

UNIT– III:
Printed Circuit Boards and Cooling – Chip packaging – thermal Resistance – Board Cooling methods – Board thermal Analysis – Equivalent thermal Conductivity
Air Cooling – Fans – Heat transfer Enhancement – Air handling systems – Blowers.
Single Phase Cooling – Coolant Selection – Natural Convection – Forced Convection - Air Cooling - Convective cooling in Small systems – Forced cooling in medium and large systems – Liquid cooling in high power modules – Case Studies.

UNIT– IV:
Two Phase Cooling and Heat pipes – Direct Immersion Cooling – Basics of Pool Boiling – Enhancement of Pool Boiling – Flow Boiling
Heat Pipes – Operation Principles – Useful Characteristics – Operating Limits and Temperatures – Operation Methods – Applications – Micro Heat Pipes.

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UNIT– V:

Thermo Electric coolers: Basics theories – Thermo electric effect – Operation Principles Phase change materials, Thermal Interface materials, Heat Spreaders and Heat Sinks – Working Principles, Mini and Micro Channels. Use of nano fluids in electronic cooling.

TEXT BOOKS:

1. Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram BarCohen, McGraw Hill, New York, NY, 1983.
2. Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.

REFERENCE BOOKS:

1) Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990.

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

CO1: Apply the basics of heat transfer and analyze heat transfer through fins
CO2: Analyze the basics of convection and radiation modes of heat transfer.
CO3: Analyze knowledge about the thermal analysis of printed circuit boards and their cooling.
CO4: Explain the principles of two-phase cooling and heat pipes.
CO5: Justify knowledge about the thermoelectric coolers.

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III Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
FINITE ELEMENT METHODS (PE-1)					

Course objectives:
1) To understand the basic principles of finite element methods.
2) To understand discretization principles and apply to analyse the trusses.
3) To apply the finite element method to analyze and solve beam problems.
4) To gain knowledge about two dimensional stress analysis.
5) To understand and apply steady state analysis and dynamic analysis.

UNIT– I:
Finite Element Methods: 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:
Discretization: Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.
Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations

UNIT– III:
Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT– IV:
Finite element modeling: Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axi-symmetric problems.
Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

UNIT– V:
Steady state heat transfer analysis: One dimensional analysis of a fin.
Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

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TEXT BOOKS:

1) The Finite Element Methods in Engineering /S.S.Rao /Pergamon.
2) Introduction to Finite Elements in Engineering, Second Edition/ Tirupati Reddy Chandrupatla/ Prentice-Hall.

REFERENCES:

1) Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2) An introduction to Finite Element Method /JNReddy/McGraw-Hill
3) The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst, DouglasE. Smith andTed G. By rom/John Wiley & sons (ASIA) Pvt Ltd.
4) Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5) Finite Element Analysis: for students & Practicing Engineers / G.Lakshmi Narasaiah.

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

CO1: Apply basic principles of finite element methods.
CO2: Analyze about discretization principles and apply to analyse the trusses.
CO3: Apply the finite element method to analyze and solve beam problems.
CO4: Judge the knowledge about two dimensional stress analysis.
CO5: Apply steady state and dynamic analysis.

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III Year - I Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL ROBOTICS (PE-1)					

Course objectives:
1) To understand the concepts of robotics and its systems.
2) To gain knowledge about the motion analysis and manipulator kinematics.
3) To understand the differential transformations.
4) To understand the basics about path description and generation.
5) To acquire knowledge about the actuators, feedback components and robotic applications.

UNIT– I:
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, comparison of Electric, Hydraulic and Pneumatic types of actuation devices.

UNIT– II:
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– III:
DIFFERENTIAL TRANSFORMATION: Jacobians – problems, robot dynamic arm dynamics: Lagrange –Euler and Newton – Euler formulations–Problems – generalized D – Alembert's Equation of motion.

UNIT– IV:
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.

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UNIT– V:

ROBOT ACTUATORS AND FEED BACK COMPONENTS: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors–potentiometers, resolvers, encoders–Velocity sensors.

ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer - Material handling, loading and unloading- Processing -spot and continuous arc welding &spray painting- Assembly and Inspection.

TEXTBOOKS:

1) Industrial Robotics / Groover MP /Pearson Edu.
2) Robotics and Control /Mittal R K & Nagrathi J /TMH.

REFERENCES:

1) Robotics/Fu KS/ McGraw-Hill.
2) Robotic Engineering /Richard D. Klafter, Prentice Hall
3) Robot Analysis and Control/ H. Asada and J.J.E. Slotine /BSP Books Pvt.Ltd.
4) Introduction to Robotics/John JCraig/Pearson Edu.

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

CO1: Perceive the concepts of robotics and its sytems.
CO2: Apply knowledge about the motion analysis and manipulator kinematics.
CO3: Analyze the differential transformations.
CO4: Apply the basics about path description and generation.
CO5: Judge about the actuators, feedback components and robotic applications.

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III Year - I Semester		L	T	P	C
		3	0	0	3
ADVANCED MATERIALS (PE-1)					

Course objectives:
1) To gain knowledge about the metals and alloys and their utility in different environments.
2) To acquire knowledge about polymers and ceramics and their applications.
3) To analyze composite materials along with reinforcements and their applications.
4) To understand the basics of shape memory alloys and functionally graded materials.
5) To gain knowledge about the nanomaterials and their applications.

UNIT– I:
METALS & ALLOYS: Metallic materials- super alloys, Aluminium, Magnesium, titanium and Nickel based alloys and inter-metallics, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Introduction to metallic foams.

UNIT– II:
POLYMERS: Natural Polymers-Synthetic polymers- Chemical & Physical structure, properties-glass-transition temperature-Thermosets-Thermoplastics- characteristics & applications of polymers-Elastomers- Processing of plastics.
CERAMICS: Applications-characteristics- classification-Processing of ceramics- Powder preparations- consolidation- hot compaction-drying- sintering-finishing of ceramics-Areas of application.

UNIT– III:
COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications
REINFORCEMENTS: Fibers- glass, silica, Kevlar, carbon, boron, silicon carbide, and boron carbide fibers.

UNIT– IV:
SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.
FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials.

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UNIT– V:

NANO MATERIALS: Introduction-properties at nano scales-advantages & disadvantages applications in comparison with bulk materials (nano–structure, wires, tubes, composites).

TEXT BOOKS:
1) Nanomaterial /A.K. Bandyopadyay/New age Publishers.
2) Material science and Technology: A comprehensive treatment/Robert W.Cahn, /VCH.
3) Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press.

REFERENCES:
1) Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2) Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969.
3) Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-Inter science, New York, 1980.
4) Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /Autar K.Kaw /CRC Press.

Course Outcomes: At the end of the course, student will be able to
CO1: Justify the knowledge about metals and alloys and their utility in different environments.
CO2: Judge about polymers and ceramics and their applications.
CO3: Analyze composite materials along with reinforcements and their applications.
CO4: Utilize shape memory alloys and functionally graded materials for different applications.
CO5: Justify about the nanomaterials and their applications.

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III Year - I Semester		L	T	P	C
		3	0	0	3
RENEWABLE ENERGY SOURCES (PE-1)					

Course objectives:
1) To demonstrate the importance of solar energy collection and storage.
2) To understand the wind energy principles.
3) To gain knowledge on biomass energy.
4) To know the principles of tidal energy.
5) To understand the concepts of geothermal energy.

UNIT– I:
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, numerical problems. Photo voltaic energy conversion – types of PV cells.
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– II:
WIND ENERGY: Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram.

UNIT– III:
BIOMASS ENERGY: Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass , Biomass programs in India.

UNIT– IV:
TIDAL ENERGY: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation.

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UNIT– V:

GEOTHERMAL ENERGY: Introduction, vapor and liquid dominated systems, binary cycle, hot dry rock resources, magma resources, advantages and disadvantages, applications, MHD Power generation: concept and working principle, Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms.

TEXT BOOKS:

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.
3) Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013.

REFERENCES:

1) Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New Age international.
2) Principles of Solar Engineering - D.Yogi Goswami, 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.
6) Renewable Energy Resources-2nd Edition/ J.Twidell and T. Weir/ BSP Books Pvt.Ltd.
7) Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd.

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

CO1: Explain the importance of, solar energy collection and storage.
CO2: Discuss the wind energy principles.
CO3: Analyze about biomass energy concepts.
CO4: Apply the principles of tidal energy.
CO5: Utilize the concepts of geothermal energy.

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III Year - I Semester		L	T	P	C
		3	0	0	3
MECHANICS OF COMPOSITES (PE-1)					

Course objectives*:*
1) To understand about the composite materials and their classification.
2) To illustrate micro mechanical analysis of a lamina.
3) To gain knowledge about the two dimensional angle lamina.
4) To illustrate macro mechanical analysis of a lamina.
5) To gain knowledge in designing the laminates.

UNIT– I:
INTRODUCTION TO COMPOSITES: Composites, materials- matrix and reinforcement, Particulate composites, rule of mixtures, classification of composites, Applications

UNIT– II:
MICRO MECHANICAL ANALYSIS OF A LAMINA :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion

UNIT– III:
HOOKE'S LAW FOR A TWO-DIMENSIONAL ANGLE LAMINA: Engineering Constants of an Angle Lamina, Invariant form of Stiffness and Compliance Matrices for an Angle Lamina Strength
Hygro-thermal Stresses and Strains in a Lamina: Hygro-thermal Stress–Strain relationships for a Unidirectional Lamina, Hygro-thermal Stress–Strain Relationships for an Angle Lamina

UNIT– IV:
MACRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Definitions: Stress, Strain, Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate , Hygro-thermal Effects in a Laminate, warpage of Laminates,

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UNIT– V:

DESIGN OF LAMINATES: Introduction, thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory, Failure theories, Design of Laminated Composites.

TEXT BOOKS:

1) Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2) B. D. Agarwal and L. J. Broutman, Analysis and performance of fiber Composites,Wiley-Interscience, New York, 1980.
3) Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw, CRC press.

REFERENCES:

1) R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1975.
2) L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.

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

CO1: Discuss the composite materials and their classification.
CO2: Apply the micro mechanical analysis of a lamina.
CO3: Learn about two dimensional angle lamina.
CO4: Apply the macro mechanical analysis of a lamina.
CO5: Utilize knowledge in designing the laminates.

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III Year - I Semester		L	T	P	C
		0	0	3	1.5
MACHINE TOOLS LABORATORY					

Course objectives:
1) To understand general purpose machine tools in the machine shop.
2) To demonstrate various operations on lathe machine.
3) To demonstrate different operations on drilling machine.
4) To demonstrate basic operations on shaping machine.
5) To demonstrate the making of keyways on slotting machine.
6) To demonstrate the basic operations on milling machine.

Students are expected to perform the following experiments on different machine tools.

1) Introduction of general purpose machines -Lathe, Drilling machine, Milling machine, Shaper, Planing machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.
2) Operations on Lathe machine
    a) Step turning and Knurling
    b) Taper turning and Knurling
    c) Thread cutting and knurling
    d) Drilling and tapping
3) Operations on Drilling machine
    a) Drilling, reaming and tapping
    b) Rectangular drilling
    c) Circumferential drilling
4) Operations on Shaping machine
    a) Round to square
    b) Round to Hexagonal
5) Operations on Slotter
    a) Keyway (T–slot)
    b) Keyway cutting
6) Operations on milling machines
    a) Indexing
    b) Gear manufacturing

Course Outcomes: At the end of the course, student will be able to
CO1: Demonstrate about general purpose machine tools in the machine shop.
CO2: Perform various operations on lathe machine.
CO3: Perceive different operations on drilling machine.
CO4: Experiment with basic operations on shaping machine.
CO5: Utilize slotting machine to make keyways.
CO6: Experiment with the basic operations on milling machine.

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III Year - I Semester		L	T	P	C
		0	0	3	1.5
THERMAL ENGINEERING LAB					

Course objectives:

1) To demonstrate the characteristics of two stroke and four stroke compression and spark ignition engines.
2) To determine flash point, fire point, calorific value of different fuels using various apparatus.
3) To determine engine friction, heat balance test, volumetric efficiency, load test of petrol and diesel engines.
4) To demonstrate speed test, performance test and cooling temperature on petrol and diesel engines.
5) To demonstrate performance test and determine efficiency of air compressor.
6) To understand the principles through assembly and disassembly of 2/3 wheelers, 2/4 stroke engines, tractor, heavy duty engines and boilers and their mountings and accessories.

Experiments :

1. To determine the actual Valve Timing diagram of a four stroke Compression/Spark Ignition Engine.
2. To determine the actual Port Timing diagram of a two stroke Compression/Spark Ignition Engine.
3. Determination of Flash & Fire points of Liquid fuels / Lubricants using (i) Abels Apparatus; (ii) Pensky Martin's apparatus and (iii) Cleveland's apparatus.
4. Determination of Viscosity of Liquid lubricants/Fuels using (i) Saybolt Viscometer and (ii) Redwood Viscometer.
5. Determination of Calorific value of Gaseous Fuels using Junkers Gas Calorimeter.
6. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol/diesel engine.
7. Evaluation of Engine Friction by Motoring/Retardation Test on a Single Cylinder 4 Stroke Petrol/Diesel Engine.
8. To perform the Heat Balance Test on Single Cylinder four Stroke Petrol/Diesel Engine.
9. Determination of Air/Fuel Ratio and Volumetric Efficiency on a four Stroke Petrol/Diesel Engine.
10. To conduct a load test on a single cylinder Petrol/Diesel engine to study its performance under various loads.
11. To determine the optimum cooling temperature of a Petrol/Diesel engine.
12. To conduct economical speed test on a four stroke Petrol/Diesel engine.
13. To conduct a performance test on a VCR engine, under different compression ratios and determine its heat balance sheet.
14. To conduct a performance test on an air compressor and determine its different efficiencies.
15. Dis-assembly / assembly of different parts of two wheelers. 3 wheelers & 4 wheelers. Tractor & Heavy duty engines covering 2-stroke and 4 stroke, SI and CI engines.Study of Boilers with mountings and accessories.

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

CO1: Experiment with two stroke and four stroke compression and spark ignition engines for various characteristics.
CO2: Perceive flash point, fire point, calorific value of different fuels using various apparatus.
CO3: Perform engine friction, heat balance test, volumetric efficiency, load test of petrol and diesel engines.
CO4: Perform speed test, performance test and cooling temperature on petrol and diesel engines.
CO5: Utilize air compressor for its performance test and to determine efficiency.
CO6: Discuss the principles through assembly and disassembly of 2/3 wheelers, 2/4 stroke engines, tractor, heavy duty engines, boilers and their mountings and accessories.

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III Year - I Semester		L	T	P	C
		1	0	2	2
ADVANCED COMMUNICATION SKILLS LAB					

Introduction

A course on *Advanced English Communication Skills (AECS) Lab* is considered essential at the third year level of B.Tech. At this stage, the students need to prepare themselves for their career which requires them to listen to, read, speak and write in English both for their professional and interpersonal communication. The main purpose of this course is to prepare the students of Engineering for their placements.

Course Objectives: This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve students' fluency in spoken English
- To enable them to listen to English spoken at normal conversational speed
- To help students develop their vocabulary
- To read and comprehend texts in different contexts
- To communicate their ideas relevantly and coherently in writing
- To make students industry-ready
- To help students acquire behavioural skills for their personal and professional life
- To respond appropriately in different socio-cultural and professional contexts

Learning Outcomes: Students will be able to:

- Acquire vocabulary and use it contextually
- Listen and speak effectively
- Develop proficiency in academic reading and writing
- Increase possibilities of job prospects

Communicate confidently in formal and informal contexts

Syllabus

The following course activities will be conducted as part of the Advanced English Communication Skills (AECS) Lab:

1. **Inter-personal Communication and Vocabulary Building** - Starting a Conversation – Responding Appropriately and Relevantly – Role Play in Different Situations - Synonyms and Antonyms, One- word Substitutes, Prefixes and Suffixes, Idioms and Phrases and Collocations.
2. **Reading Comprehension and Listening Skills** –General Vs Local Comprehension, Techniques- Reading for Facts, Guessing Meanings from Context, Skimming, Scanning, Inferring Meaning-Listening Comprehension(Video/Audio talks)
3. **Technical Writing Skills** – Structure and Presentation of Different Types of Writing – Letter Writing/Resume Writing/ e-correspondence/ Technical Report Writing- Circular writing/ Meeting agenda/ Minutes of Meeting.

4. **Presentation Skills** – Public speaking-Oral Presentations (individual or group) through JAM Sessions/Seminars/PPTs and Written Presentations through Posters/Projects/Reports/ e-mails/Assignments… etc.,- Stage dynamics- Body Language- Para Language.
5. **Getting Ready for the Job:**
   a. **Group Discussion and Interview Skills** – Dynamics of Group Discussion, Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas and Rubrics of Evaluation- Concept and Process, Pre-interview Planning, Opening Strategies, Answering Strategies, Interview through Tele-conference & Video-conference and Mock Interviews.

   b. Soft Skills: Inter and Intra Personal Skills.

Minimum Hardware Requirement:

Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 30 students in the lab:

- **Spacious room with appropriate acoustics**
- **Eight round tables with five movable chairs for each table.**
- **Audio-visual aids**
- **LCD Projector**
- **Public Address system**
- **Computer with suitable configuration**

Suggested Software: The software consisting of the prescribed topics elaborated above should be procured and used.

- **Oxford Advanced Learner's Compass**, 10th Edition.
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**
- **TOEFL & GRE(KAPLAN, AARCO & BARRONS, USA, CRACKING GRE by CLIFFS)**
- **TRAIN2SUCCESS.COM**

Suggested Reading:

1. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press2009.
2. Technical Communication by Paul V.Anderson.2007. Cengage Learning pvt. Ltd. NewDelhi.
3. Business and Professional Communication: Keys for Workplace Excellence .Kelly M. Quintanilla& ShawnT.Wahl. SageSouth AsiaEdition. SagePublications.2011.
4. The Basics of Communication: A Relational Perspective. Steve Duck & David T.McMahan. Sage South AsiaEdition.SagePublications.2012.
5. English Vocabulary in Use series, CambridgeUniversityPress2008.
6. Management Shapers Series by Universities Press (lndia) Pvt Ltd., Himayatnagar, Hyderabad2008.
7. Handbook for Technical Communication by David A.McMurrey & Joanne Buckley.2012.

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8. Handbook for Technical Writing by David A McMurrey & JoanneBuckely CENGAGE Learning 2008.
9. Job Hunting by Colm Downes, Cambridge University Press2008.
10. Master Public Speaking by Anne Nicholls, JAICOPublishingHouse,2006.
11. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hil 2009.
12. Books on TOEFL/GRE/GMAT/CAT/IELTS/SAT by Barron's/DELTA/Cambridge University Press.
13. The Definitive Book of body Language – by Allan Pease, Barbara Pease.

Sample Web references:

Listening

- https://learningenglish.voanews.com/z/3613
- http://www.englishmedialab.com/listening.html

Speaking

- https://www.talkenglish.com/
- BBC Learning English – Pronunciation tips
- Merriam-Webster – Perfect pronunciation Exercises

All Skills

- https://www.englishclub.com/
- http://www.world-english.org/
- http://learnenglish.britishcouncil.org/

Online Dictionaries

- Cambridge dictionary online
- MacMillan dictionary
- Oxford learner's dictionaries

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - I Semester		L	T	P	C
		2	0	0	0
PROFESSIONAL ETHICS AND HUMAN VALUES					

Course objective:

1) To understand the concepts of human values.
2) To gain knowledge about the principles of engineering ethics.
3) To interpret engineering as social experimentation.
4) To understand engineers' responsibility for safety and risk.
5) To gain knowledge about the engineers' rights and responsibilities.

UNIT– I:
HUMAN VALUES: Morals, Values and Ethics – Integrity – Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing –Honesty –Courage – Value time – Co-operation – Commitment – Empathy –Self-confidence – Spirituality- Character.

UNIT– II:
ENGINEERING ETHICS:
The History of Ethics-Purposes for Engineering Ethics-Engineering Ethics-Consensus and Controversy –Professional and Professionalism –Professional Roles to be played by an Engineer – Self Interest, Customs and Religion-Uses of Ethical Theories-Professional Ethics-Types of Inquiry – Engineering and Ethics-Kohlberg's Theory – Gilligan's Argument –Heinz's Dilemma.

UNIT– III:
ENGINEERING AS SOCIAL EXPERIMENTATION:
Comparison with Standard Experiments – Knowledge gained –Conscientiousness – Relevant Information – Learning from the Past – Engineers as Managers, Consultants, and Leaders – Accountability – Role of Codes – Codes and Experimental Nature of Engineering.

UNIT– IV:
ENGINEERS' RESPONSIBILITY FOR SAFETY AND RISK:
Safety and Risk, Concept of Safety – Types of Risks – Voluntary v/s Involuntary Risk- Short term v/s Long term Consequences- Expected Probability- Reversible Effects- Threshold Levels for Risk-Delayed v/s Immediate Risk- Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis-Accidents.

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UNIT– V:
ENGINEERS' RESPONSIBILITIES AND RIGHTS:
Collegiality-Techniques for Achieving Collegiality –Two Senses of Loyalty-obligations of Loyalty-misguided Loyalty – professionalism and Loyalty-Professional Rights –Professional Responsibilities – confidential and proprietary information-Conflict of Interest-solving conflict problems – Self-interest, Customs and Religion- Ethical egoism-Collective bargaining-Confidentiality-Acceptance of Bribes/Gifts-when is a Gift and a Bribe-examples of Gifts v/s Bribes-problem solving-interests in other companies-Occupational Crimes-industrial espionage-price fixing-endangering lives-Whistle Blowing-types of whistle blowing-when should it be attempted-preventing whistle blowing.

TEXT BOOKS:
1) Engineering Ethics and Human Values by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009.
2) Professional Ethics and Morals by Prof.A.R.Aryasri, Dharanikota, Suyodhana-Maruthi Publications.

REFERENCE BOOKS:
1) Professional Ethics and Human Values by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran-Laxmi Publications.
2) Professional Ethics and Human Values by Prof. D. R. Kiran, TMH.
3) Indian Culture, Values and Professional Ethics by P.S.R. Murthy-BS Publication.
4) Ethics in Engineering by Mike W. Martin and Roland Schinzinger– Tata McGraw-Hill – 2003.
5) Engineering Ethics by Harris, Pritchard and Robins, CENGAGE Learning, Indian Edition, 2009.

Course outcomes: At the end of the course, student will be able to
CO1: Judge the concepts of human values.
CO2: Justify knowledge about the principles of engineering ethics.
CO3: Interpret engineering as social experimentation.
CO4: Realize engineers' responsibility for safety and risk.
CO5: Learn about the engineers' rights and responsibilities.

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SUBJECTS FOR B.Tech (MINOR) in MECHANICAL ENGINEERING

MINOR		L	T	P	C
		4	0	0	4
BASIC THERMODYNAMICS					

Course Objectives:

1) To understand the basic concepts like thermodynamic system, its boundary, related fundamental definitions and distinguish between point function and path function.
2) To understand and learn the energy conservation principle, concept of equality of temperature, principle of operation of various temperature measuring devices and applications of various flow systems.
3) To understand and apply the thermodynamics principles to heat engines & refrigerator/ heat pump and analyze the concepts of Carnot cycle, entropy, availability and irreversibility, Maxwells relations and thermodynamic functions.
4) To understand the process of steam formation and its representation on property diagrams with various phase changes and should be able to calculate the quality of steam after its expansion in a steam turbine, with the help of standard steam tables and charts.
5) To understand and apply Psychrometric chart and calculate various psychrometric properties of air.

UNIT – I

Introduction: Basic Concepts : System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process - Reversible, Quasi static & Irreversible Processes, cycle, Energy in State and in Transition - Types, Work and Heat, Point and Path function

UNIT II

Zeroth Law of Thermodynamics – Concept of Temperature - Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Steady Flow Energy Equation. PMM-I, throttling and free expansion processes.

UNIT – III

Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence, Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase.

UNIT IV

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

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UNIT – V

Mixtures of perfect Gases – Mole Fraction, Mass friction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Mole fraction , Volume fraction and partial pressure, Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, Atmospheric air - Psychrometric Properties – Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation , Carrier's Equation – Psychrometric chart.

TEXT BOOKS:

1. Engineering Thermodynamics, PK Nag 4th Edn, TMH.
2. Treatise on Heat Engineering (MKS and SI units), VP Vasandani, DS Kumar, Metropolitan books.

REFERENCES:

1. Engineering Thermodynamics – Jones & Dugan PHI
2. Thermodynamics – J.P.Holman, McGraw-Hill
3. Basic Engineering Thermodynamics – A.Venkatesh – Universities press.
4. An Introduction to Thermodynamics - Y.V.C.Rao – Universities press.
5. Thermodynamics – W.Z.Black & J.G.Hartley, 3rd Edn Pearson Publ.
6. Engineering Thermodynamics – D.P.Misra, Cengage Publ.
7. Engineering Thermodynamics – P.Chattopadhyay – Oxford Higher Edn Publ.

Course Outcomes: After undergoing the course the student is expected to learn

CO1: Basic concepts like thermodynamic system, its boundary, related fundamental definitions and distinguish between point function and path function.

CO2: Energy conservation principle, concept of equality of temperature, principle of operation of various temperature measuring devices and applications of various flow systems.

CO3: Thermodynamics principles to heat engines & refrigerator/ heat pump and analyse the concepts of Carnot cycle, entropy, availability and irreversibility, Maxwells relations and thermodynamic functions.

CO4: Process of steam formation and its representation on property diagrams with various phase changes and should be able to calculate the quality of steam after its expansion in a steam turbine, with the help of standard steam tables and charts.

CO5:To calculate various psychrometric properties of air using psychrometric charts.

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MINOR		L	T	P	C
		4	0	0	4
MANUFACTURING PROCESSES					

Course objectives:

1) To understand the basic concepts and principles of casting of different casting techniques
2) To learn the principles of metal cutting and different machine tools
3) To understand the principles of various welding processes
4) To understand the various metal forming process.
5) To understand the fundamentals of sheet metal forming with force and power requirements

UNIT-1

CASTING: Steps involved in making a casting – Advantage of casting and its applications, Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances Basic principles and applications of casting processes - Centrifugal casting – True, semi and centrifuging, Die casting, Investment casting and shell molding, Casting defects.

UNIT- II

MACHINING PROCESSES: Elementary treatment of metal cutting theory – element of cutting process – Principles of turning, drilling, milling, planning, slotting, shaping, grinding, and broaching and machine tools

UNIT– III

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

UNIT – IV

Metal FORMING PROCESS: Forging - Types of Forging, Smith forging, Drop Forging, Roll forging, forging hammers, Rotary forging, forging defects; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

UNIT – V

SHEET METAL FORMING: Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

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TEXT BOOK(S):

1. Manufacturing Technology (Foundation Forming & Welding)- P.N. Rao, Tata McGraw Hill.
2. Principles of manufacturing materials and processes- J.S.Campbell, Tata McGraw Hill.
3. Basic Manufacturing Process- D. Mishra IndiaTech Publisher, New Delhi.

REFERENCE(S):

1. Principles of manufacturing materials and processes- J.S.Campbell, Tata McGraw Hill.
2. Manufacturing Engineering and Technology, 4th Edition- S.Kalpakjian and S.R. Scsimid, Pearson Education.
3. Materials and processes in manufacturing- DeGarmo, Black and Kohser, Prentice Hall of India.
4. Principle of Metal Casting- Heine, Loper and Rosenthal, Tata McGraw Hill.

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

CO1: Learn about the basic concepts of casting
CO2: Design the gating system for different metallic components
CO3: Understand the working principles of arc and gas welding processes.
CO4: Understand principles of Forging, rolling, extrusion and drawing processes.
CO5: Illustrate the various sheet metal forming processes for a specific application.

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MINOR		L	T	P	C
		4	0	0	4
MATERIALS SCIENCE AND ENGINEERING					

Course Objective:
1) To understand the structure of metals and the necessity of alloying.
2) To understand the equilibrium diagrams and properties of alloys.
3) To obtain the knowledge about the ferrous alloys.
4) To understand the structure and properties of non-ferrous metals and alloys.
5) To understand the principles of heat treatment of alloys.

UNIT – I
Structure of Metals and Constitution of alloys: Bonds in Solids, Metallic bond, crystallization of metals, Packing Factor - SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries on the Properties of metal / alloys – determination of grain size. Imperfections – point, line, surface and volume- Slip and Twinning.
Necessity of alloying, types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds

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

UNIT – III
Ferrous Alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

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

UNIT – V
Heat treatment of Alloys: Effect of alloying elements on Fe-Fe_3C system, Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

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TEXT BOOKS:
1. Introduction to Physical Metallurgy - Sidney H. Avner -McGraw-Hill
2. Essential of Materials science and engineering - Donald R.Askeland -Cengage.

REFERENCES:
1. Material Science and Metallurgy – Dr. V.D.kodgire- Everest PublishingHouse
2. Materials Science and engineering – Callister&Baalasubrahmanyam- Wiley Publications
3. Material Science for engineering students – Fischer – ElsevierPublishers
4. Material science and Engineering - V. Rahghavan – PHIPublishers
5. Introduction to Material Science and Engineering – Yip-Wah Chung CRCPress
6. Material Science and Metallurgy – A V K Suryanarayana – B SPublications
7. Material Science and Metallurgy – U. C. Jindal – PearsonPublications

Course Outcomes: At the end of the course, students will be able
CO1: To learn the structure of metals and the necessity of alloying.
CO2: To learn the equilibrium diagrams and properties of alloys.
CO3: To learn about the ferrous alloys.
CO4: To learn the structure and properties of non-ferrous metals and alloys.
CO5: To learn the principles of heat treatment of alloys.

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DEPARTMENT OF MECHANICAL ENGINEERING

MINOR		L	T	P	C
		4	0	0	4
BASIC MECHANICAL DESIGN					

Course Objectives:

1) To understand the design procedure of engineering problems with constraints.
2) To measure the stress concentration and strength of machine elements
3) To understand the principles and apply to design the riveted and welded joints.
4) To understand design principles to design shafts and shaft couplings under different loading conditions.
5) To have knowledge of mechanical springs and apply principles to design springs for different loading conditions.

UNIT-I

INTRODUCTION: General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design, tolerances and fits –BIS codes of steels- ASHBY Charts.

STRESSES IN MACHINE MEMBERS: Simple stresses – combined stresses – torsional and bending stresses – impact stresses – stress strain relation – various theories of failure – factor of safety – design for strength and rigidity – preferred numbers-concept of stiffness in tension, bending, torsion and combined situations – static strength design based on fracture toughness.

UNIT-II

STRENGTH OF MACHINE ELEMENTS: Stress concentration – theoretical stress concentration factor – fatigue stress concentration factor notch sensitivity – design for fluctuating stresses – endurance limit – estimation of endurance strength – Goodman's line – Soderberg's line – modified Goodman's line

UNIT-III

RIVETED AND WELDED JOINTS – design of joints with initial stresses – eccentric loading. Bolted joints – design of bolts with pre-stresses – design of joints under eccentric loading – locking devices – both of uniform strength, different seals.

UNIT-IV

SHAFTS: Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads – shaft sizes – BIS code- Use of internal and external circlips-gaskets and seals (stationary & rotary).

SHAFT COUPLINGS: Rigid couplings – muff, split muff and flange couplings.

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UNIT-V

MECHANICAL SPRINGS:

Stresses and deflections of helical springs – extension -compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – co-axial springs, leaf springs.

Note: Design data book is NOT Permitted for examination.

TEXT BOOKS:

1. Machine design / NC Pandya & CS Shah/Charotar Publishing House Pvt. Limited
2. Machine Design/V.B.Bhandari/ McGraw-Hill Education

REFERENCES:

1. Design of Machine Elements / V.M. Faires/McMillan
2. Machine design / Schaum Series/McGraw-Hill Professional
3. Machine Design/ Shigley, J.E/McGraw Hill.
4. Design data handbook/ K.Mahadevan& K. Balaveera Reddy/ CBS publishers.
5. Machine Design –Norton/ Pearson publishers

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

CO1: Learn the design procedure of engineering problems with constraints.
CO2: Measure the stress concentration and strength of machine elements
CO3: Learn the principles and apply to design the riveted and welded joints.
CO4: Learn the design principles to design shafts and shaft couplings under different loading conditions.
CO5: Know about mechanical springs and apply the principles to design springs for different loading conditions.

MINOR		**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
OPTIMIZATION TECHNIQUES					

Course Objectives:

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1) To understand the classification of optimization problems and classical optimization techniques.
2) To understand and apply unconstrained optimization techniques to solve problems.
3) To understand and apply constrained optimization techniques to solve problems.
4) To obtain optimized solutions using constrained and unconstrained geometric programming
5) To understand the principles of dynamic programming and its applications.

UNIT – I

INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints- multivariable optimization with inequality constraints.

UNIT – II

UNCONSTRAINED OPTIMIZATION TECHNIQUES: Pattern search method- Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

UNIT – III

CONSTRAINED OPTIMIZATION TECHNIQUES: Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT – IV

GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming (C.G.P)

UNIT – V

DYNAMIC PROGRAMMING:

Introduction – Bellman’s principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.

TEXT BOOK:

1. Optimization Theory and Applications/ S.S.Rao/Wiley Eastern Limited, New Delhi.

REFERENCES:

1. Engineering Optimization / Kalyanmanai Deb/Prentice Hall of India, New Delhi.
2. Optimization Techniques-Theory and applications/C.Mohan&Kusum Deep/New Age International
3. Operations Research /S.D.Sharma / MacMillan Publishers

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

CO1: Learn the classification of optimization problems and classical optimization techniques.
CO2: Learn and apply unconstrained optimization techniques to solve problems.
CO3: Learn and apply constrained optimization techniques to solve problems.
CO4: Learn to obtain optimized solutions using constrained and unconstrained geometric programming.

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CO5: Learn the principles of dynamic programming and its applications.

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MINOR		L	T	P	C
		4	0	0	4
POWER PLANT ENGINEERING					

Course Objectives:

1) To understand the sources of energy and concepts of steam power plant.
2) To design of components of steam, gas and diesel power plants.
3) To explain the principles of hydro power plant and nuclear power station.
4) To apply the concepts of nuclear reactors and understand the operations of different power plants.
5) To understand the principles and concepts relevant to power plant instrumentation, control, economics and environmental considerations.

UNIT – I

Introduction to the sources of energy – resources and development of power in India.

STEAM POWER PLANT: Plant layout, working of different circuits, fuel handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components,

UNIT – II

STEAM POWER PLANT: Combustion needs and draught system, cyclone furnace, design and Construction, dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment.

INTERNAL COMBUSTION AND GAS TURBINE POWER PLANTS:

DIESEL POWER PLANT: Plant layout with auxiliaries – fuel supply system, air starting equipment, super charging.

GAS TURBINE PLANT: Introduction – classification - construction – layout with auxiliaries, combined cycle power plants and comparison.

UNIT – III

HYDRO ELECTRIC POWER PLANT: Water power – hydrological cycle / flow measurement – drainage area characteristics – hydrographs – storage and pondage – classification of dams and spillways.

HYDRO PROJECTS AND PLANT: Classification – typical layouts – plant auxiliaries – plantoperation pumped storage plants.

NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.

UNIT – IV

TYPES OF NUCLEAR REACTORS: Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.

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COMBINED OPERATIONS OF DIFFERENT POWER PLANTS: Introduction, advantages of combined working, load division between power stations, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro-electric and gas turbine stations, co-ordination of hydro-electric and nuclear power stations, co-ordination of different types of power plants.

UNIT – V

POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O_2 and CO_2 measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit, nuclear measurements, smart grids, power plant control room.

POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises. Effluents from power plants and Impact on environment –pollutants and pollution standards – methods of pollution control.

TEXT BOOKS:

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub

REFERENCES:

1. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGraw-Hill.
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers

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

CO1: Illustrate the functions of different components of steam power plant
CO2: Describe basic working principles, performance characteristics and components of gas turbine and diesel power plants
CO3: Illustrate basic working principles of hydroelectric power plants and analyze the importance of hydrological cycles, measurements and drainage characteristics
CO4: Learn about the principal components and types of nuclear reactors
CO5: Analyze the working of power plant instrumentation and estimate the economics of power plants

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		L	T	P	C
MINOR		**4**	**0**	**0**	**4**
AUTOMOBILE ENGINEERING					

Course Objectives:

1) To learn basic components and functions of automobile
2) To learn the various elements and working of transmission system of automobile
3) To learn the working of braking system and suspension system of automobile
4) To learn the concepts involved in the electrical system of automobile, engine.
5) To learn the concepts involved in the automobile electronic systems and engine service of different Parts

UNIT – I

INTRODUCTION: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobileengines, engine construction, oil filters, oil pumps – crank case ventilation – engine service,reboring, decarbonisation, Nitriding of crank shaft.

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle train, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davissteering mechanism, steering gears – types, steering linkages.

UNIT-II

TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multiplate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh,construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles –
Types – wheels and tyres.

UNIT – III

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, and wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

UNIT – IV

ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, Bendix drive mechanism, solenoid switch, lighting systems, horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

ENGINE SPECIFICATION AND SAFETY SYSTEMS: Introduction- engine specifications with regard to power, speed, torque, no. of cylinders and arrangement, lubrication and cooling etc. Safety: Introduction, safety systems - seat belt, air bags, bumper, anti-lock brake system (ABS), wind shield, suspension sensors, traction control, mirrors, central locking and electric windows, speed control.

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UNIT-V

ENGINE EMISSION CONTROL: Introduction – types of pollutants, mechanism of formation, concentration measurement, methods of controlling-engine modification, exhaust gas treatment-thermal and catalytic converters-use of alternative fuels for emission control – National and International pollution standards

ENGINE SERVICE: Introduction, service details of engine cylinder head, valves and valve mechanism, piston-connecting rod assembly, cylinder block, crank shaft and main bearings, engine reassembly-precautions.

TEXT BOOKS:

1. Automotive Mechanics – Vol. 1 & Vol. 2 / Kirpal Singh/standard publishers
2. Automobile Engineering / William Crouse/TMH Distributors
3. Automobile Engineering/P.S Gill/S.K. Kataria& Sons/New Delhi.

REFERENCES:

1. Automotive Engines Theory and Servicing/James D. Halderman and Chase D. Mitchell Jr., / Pearson education Inc.
2. Automotive Engineering / K Newton, W.Steeds& TK Garrett/SAE
3. Automotive Mechanics: Principles and Practices/ Joseph Heitner/Van Nostrand Reinhold
4. Automobile Engineering / C Srinivasan/McGraw-Hill

Course Outcomes: Upon successful completion of this course the student should be able to:

CO1: Acquire the basic knowledge of anatomy of an automobile and realize the functions of various steering systems.
CO2: Understand the systems of automobile transmission systems
CO3: Understand various braking and suspension systems used in automobiles
CO4: Acquire the knowledge of engine specifications and safety systems and its components
CO5: Explain the systems of engine servicing and emission control systems

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4	0	0	4

INDUSTRIAL ENGINEERING AND MANAGEMENT

Course Objectives:

1) To understand the scientific principles of management to improve productivity.
2) To impart the knowledge of financial management.
3) To understand the types of plant layout and principles of statistical quality control
4) To explain the concepts of human resources management
5) To apply project management techniques in solving project related issues.

UNIT-I

Introduction: Definition of Industrial Engineering, development, applications, Role of an industrial engineer, 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.

UNIT-II

Financial Management: Concept, meaning and functions of financial management, shares, bonds, debentures, time value of money, evaluation of financial alternatives, numerical problems. Capital budgeting - Marketing Management- Functions, strategies, channels of distributions. Operations Management: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

UNIT-III

Plant layout: Definition, types and principles of plant layouts. Statistical Quality Control: Control charts and its applications- X, R and σ charts and their applications, numerical examples.

UNIT-IV

Human Resource management: Concept and functions of Human Resource Management, Industrial relations, Job-evaluation and merit rating, wage and salary administration. Value analysis: Value engineering, implementation procedure.

UNIT-V

Project management: PERT, CPM – differences, applications, critical path, determination of floats, importance, project crashing, smoothing and numerical examples.

TEXT BOOKS:

1. Industrial Engineering and Management by O.P Khanna, Khanna Publishers.
2. Industrial Engineering and Production Management, Martand Telsang, S.ChandCompany Ltd. New Delhi.

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REFERENCES:

1. Operations Management by J.G Monks, McGraw-Hill Publishers.
2. Production and Operations Management – R.Panneerselvam- PHI- 3rd Edition
3. Industrial Engineering by Banga & Sharma.
4. Principles of Management by Koontz O' Donnel, McGraw Hill Publishers.
5. PERT/CPM by L.S Srinath, East west Press.
6. Production and operations management by K.C Arora.
7. Statistical Quality Control by Gupta.
8. Manufacturing Organization and Management, Harold T. Amrine, John A. Ritchey, Colin L. Moodie &Joseph F. Kmec, Pearson
9. Essentials of HRM and IR: P.Subba Rao, Himalaya Publishing House, Hyderabad,2015.
10. Introduction to Management Science: Kumar, Rao, Chhalill, Cengage Learning, New Delhi, 2012.

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

CO1: Learn the scientific principles of management to improve productivity.
CO2: Gain the knowledge of financial management.
CO3: Learn the types of plant layout and principles of statistical quality control.
CO4: Apply the concepts of human resources management.
CO5: Analyze project related issues and solve through project management techniques.

MINOR		L	T	P	C

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4	0	0	4

PRODUCT DESIGN AND DEVELOPMENT

Course Objectives:

1) To understand the basic concepts of product design process
2) To interpret the operations of product management and impact of manufacturing processes on product decisions
3) To understand concepts of risks and reliability of the products design.
4) To interpret the various testing procedure of the product design.
5) To understand the concepts of maintenance concepts and procedures of product design

UNIT-I

Product Design Process: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees. Modelling and Simulation: Triz, Role of Models in Engineering Design, Mathematical Modelling, Similitude and Scale Models, Computer Simulation, Geometric Modelling on Computer, Finite-Element Analysis.

UNIT-II

Product management: The operation of product management: Customer focus of product management, product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle theory, assessment and practice.

Product development: Managing new products, Generating ideas, Sources of product innovation, selecting the best ideas, the political dimension of product design, Managing the product launch and customer feedback.

Product managers and manufacturing: The need for effective relationships, the impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

UNIT-III

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature

UNIT-IV

Product Testing; Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data

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UNIT-V

Design For Maintainability: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs. Design Standardization and Cost Reduction: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

TEXT BOOKS:

1. Engineering Design, George E. Dieter, McGraw-Hill
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer

REFERENCES:

1. The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
2. New Product Design, Ulrich Eppinger,
3. Product Design, Kevin Otto.

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

CO1: Understand the basic concepts of product design process

CO2: Identify the operations of product management and impact of manufacturing processes on product decisions

CO3: Understand concepts of risks and reliability of the products design

CO4: Interpret the various testing procedure of the product design.

CO5: Illustrate the concepts of maintenance concepts and procedures of product design

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DEPARTMENT OF MECHANICAL ENGINEERING

MINOR		L	T	P	C
		4	0	0	4
SMART MANUFACTURING					

Course objectives:

1) To understand concepts of smart manufacturing.
2) To gain knowledge about smart machines and sensors.
3) To understand the principles of IoT connectivity to industry 4.0.
4) To acquire knowledge about digital twin and its applications and machine learning and artificial intelligence in manufacturing.
5) To understand the basic concepts of metaverse.

UNIT-I

Concepts of Smart Manufacturing: Definition and key characteristics of smart manufacturing, Corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing Six big losses in manufacturing with Industry 4.0, and their benefits

UNIT-II

Smart Machines and Smart Sensors: Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Introduction to IoT, IIoT, and Cyber physical systems, Sensing for Manufacturing Process in IIoT, Block Diagram of an IoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces.

UNIT-III

IoT connectivity for Industry 4.0: Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol.

UNIT-IV

Digital Twin: Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology

Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing: Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML

UNIT-V

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Metaverse – Evolution of Metaverse, Introduction to Metaverse, How Web 3.0 is changing the Internet, Asset Classes Inside the Metaverse, Land, Coins, Characters/ Avatars, Skins, Utility, Industries Disrupted by the Metaverse, Smart wearables,

TEXT BOOKS:

1) Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
2) Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
3) Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
4) AurélienGéron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media, 2017.
5) Artificial Intelligence and Machine Learning, Principles and applications by Vinod Chandra S.S., Anand Hareendran S., PHI.

REFERENCE BOOKS:

1) Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
2) Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
3) MACHINE LEARNING: A PRACTITIONER'S APPROACH, by Vinod Chandra S.S., Anand Hareendran S., PHI.
4) M.C. Trivedi, A Classical Approach to Artifical Intelligence, Khanna Publishing House,New Delhi, 2018.
5) S. Kaushik, Artificial Intelligence, Cengage Learning India, 2011.

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

CO1: Apply the basic concepts of smart manufacturing.
CO2: Analyze about smart machines and sensors.
CO3: Utilize the principles of IoT connectivity to industry 4.0.
CO4: Perceive about digital twin and its applications and machine learning and artificial intelligence in manufacturing.
CO5: Learn the basic concepts of metaverse.

MINOR		L	T	P	C

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DEPARTMENT OF MECHANICAL ENGINEERING

4	0	0	4

MECHANICAL MEASUREMENTS

Course objectives:

1) To understand the principles of measurement systems and measurement of displacement.
2) To understand the measurement concepts of temperature and pressure.
3) To understand the concepts of measurement of level and the measurement of flow and speed.
4) To know the concepts of measurement of stress and strain.
5) To apply the concepts in measuring the humidity, force, torque and power.

UNIT – I:

Definition – Basic principles of measurement – measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. Static and dynamic performance characteristics – sources of error, classification and elimination of error.

MEASUREMENT OF DISPLACEMENT: Theory and construction of various transducers to measure displacement – Piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers, calibration procedures.

UNIT – II:

MEASUREMENT OF TEMPERATURE: Classification – ranges – various principles of measurement – expansion, electrical resistance – thermistor – thermocouple – pyrometers – temperature indicators.

MEASUREMENT OF PRESSURE: Units – classification – different principles used, manometers, piston, bourdon pressure gauges, and bellows – diaphragm gauges. Low pressure measurement – thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge.

UNIT – III:

MEASUREMENT OF LEVEL: Direct method – indirect methods – capacitive, ultrasonic, magnetic,cryogenic fuel level indicators – bubbler level indicators.

FLOW MEASUREMENT: Rotameter, magnetic, ultrasonic, turbine flow meter, hot – wire anemometer, laser doppler anemometer (LDA).

MEASUREMENT OF SPEED: Mechanical tachometers – electrical tachometers – stroboscope,

Non-contact type of tachometer Measurement of Acceleration and Vibration: Different simple instruments – principles of seismic instruments – vibrometer and accelerometer using this principle.

UNIT – IV:

STRESS STRAIN MEASUREMENTS: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, strain gauge rosettes.

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UNIT – V:
MEASUREMENT OF HUMIDITY – Moisture content of gases, sling psychrometer, absorption Psychrometer, dew point meter.
MEASUREMENT OF FORCE, TORQUE AND POWER- Elastic force meters, load cells, torsionmeters, dynamometers.

TEXT BOOKS:
1. Measurement Systems: Applications & design / D.S Kumar/
2. Mechanical Measurements / BeckWith, Marangoni,Linehard, Pearson

REFERENCES:
1. Measurement systems: Application and design/Doeblin Earnest. O. Adaptation/ TMH
2. Experimental Methods for Engineers / J.P.Holman/McGraw Hill
3. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.
4. Instrumentation, measurement & analysis / B.C.Nakra & K.K.Choudhary/TMH

Course outcomes: At the end of the course, student will be able to
CO 1: Learn the principles of measurement systems and measurement of displacement.
CO 2: Learn the measurement concepts of temperature and pressure.
CO 3: Apply the concepts of measurement of level and the measurement of flow and speed.
CO 4: Learn the concepts of measurement of stress and strain.
CO 5: Apply the concepts in measuring the humidity, force, torque and power.

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DEPARTMENT OF MECHANICAL ENGINEERING

MINOR		L	T	P	C
		4	0	0	4
INDUSTRIAL ROBOTICS					

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.

UNIT – I:

INTRODUCTION: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics – present and future applications – classification by coordinate system and control system.

COMPONENTS OFTHE 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:

ROBOT ACTUATORS AND FEEDBACK 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:

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:

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:

IMAGE PROCESSING AND MACHINE VISION: Introduction to Machine Vision, Sensing and Digitizing function in Machine Vision, Training and Vision System, Robotic Applications.

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TEXTBOOKS:

1. Industrial Robotics/GrooverMP/Pearson Edu.
2. Robotics and Control /MittalR K & Nagrathi J /TMH.

REFERENCES:

1. Robotics/Fu KS/ McGrawHill.
2. Robotic Engineering /RichardD. Klafter, PrenticeHall
3. Robot Analysis and Control/ H. Asada and J.J.E. Slotine/BSP Books Pvt.Ltd.
4. Introduction to Robotics/John JCraig/PearsonEdu.

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

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

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MINOR		L	T	P	C
		4	0	0	4
MECHATRONICS					

Course Objectives:

1) To understand the use the various mechatronics systems, measurement systems, sensors and transducers.
2) To apply the concepts of solid state electronic devices.
3) To identify the components in the design of electro mechanical systems.
4) To apply the concepts of digital electronics and applications of PLCs for control.
5) To understand system interfacing, data acquisition and design of mechatronics systems.

UNIT – I:

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT – II:

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering

UNIT – III:

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT – IV:

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT – V:

System interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan& MS Balasundaram/WILEY India Edition

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REFERENCES:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford UniversityPress
2. Mechatronics Source Book / Newton C Braga/ThomsonPublications,Chennai.
3. Mechatronics – N. Shanmugam / Anuradha AgenciesPublishers.
4. Mechatronics System Design / Devdasshetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W.Bolton/ Pearson,2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indianprint

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

CO 1: Understand the use the various mechatronics systems, measurement systems, sensors and transducers.
CO 2: Apply the concepts of solid state electronic devices.
CO 3: Identify the components in the design of electro mechanical systems.
CO 4: Apply the concepts of digital electronics and applications of PLCs for control.
CO 5: Understand system interfacing, data acquisition and design of mechatronics systems.

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HONORS IN MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
ADVANCED MECHANICS OF FLUIDS					

Course Objectives:

1) To understand the general concepts of in viscid flow of incompressible fluids.
2) To apply the concepts of viscous flow.
3) To analyze the boundary layer concepts and expressions for local and mean drag coefficients for different velocity profiles.
4) To understand fundamental concept of turbulence.
5) To illustrate the compressible fluid flow and supersonic wave drag

UNIT – I:

Introduction: Basics of Fluid Mechanics – Continuity Equation – Euler's Equation – Bernoulli's equation

Viscous Flow: Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poiseuille flow, Couette flow with and without pressure gradient, Hagen Poiseuille flow

UNIT – II:

Boundary Layer Concepts: Prandtl contribution to real fluid flows – Prandtl boundary layer theory, Boundary layer thickness for flow over a flat plate – Blasius solution. Von-Karman momentum integral equation for laminar boundary layer — Expressions for local and mean drag coefficients for different velocity profiles.

UNIT – III:

Introduction to Turbulent Flow: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations, Prandtl Mixing Length Model - Universal Velocity Distribution Law - Van Driest Model – k-epsilon model, boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders.

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UNIT – IV:
Internal Flow: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth and rough Pipes – Roughness of Commercial Pipes – Moody's diagram.
Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy , Acoustic Velocity, Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State.

UNIT – V:
Compressible Fluid Flow – II: Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Rayleigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXT BOOKS:
1. Fluid Mechanics / L. Victor Streeter / TMH
2. Fluid Mechanics / Frank M. White / MGH

REFERENCES:
1. Fluid Mechanics and Machines/ Modi and Seth/Standard Book House
2. Fluid Mechanics/Cohen and Kundu/Elsevier/5th edition
3. Fluid Mechanics/Potter/Cengage Learning
4. Fluid Mechanics/William S Janna/CRC Press
5. Fluid Mechanics / Y.A Cengel and J.M Cimbala/MGH
6. Boundary Layer Theory/ Schlichting H /Springer Publications
7. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
8. Fluid Dynamics/ William F. Hughes & John A. Brighton/TMH
9. Fluid Mechanics / K.L Kumar /S Chand & Co.

Course Outcomes: At the end of the course, student will be able to
CO 1: Understand the general concepts of in viscid flow of incompressible fluids.
CO 2: Apply the concepts of viscous flow.
CO 3: Analyse the boundary layer concepts and expressions for local and mean drag coefficients for different velocity profiles.
CO 4: Understand fundamental concept of turbulence.
CO 5: Illustrate the compressible fluid flow and supersonic wave drag.

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4

GREEN MANUFACTURING

Course Objectives:
1) To understand concepts of green manufacturing
2) To illustrate various recycling techniques.
3) To apply concepts of green design methods.
4) To understand the concepts of eco design and emission less manufacturing.
5) To apply concepts of the sustainable economic environment.

UNIT – I:
Environmental effects and environmental damage – In efficient energy use – Concepts of Green Manufacturing. Waste – Collection, sorting, cleaning –Characterization of waste streams.

UNIT – II:
Recycling Techniques: Recycling rate, material recovery facilities – Integrating recycling with landfills – Processing equipments, Processing facilities for recyclable materials

UNIT – III:
Green design methods: Mass balance analysis – Green indicate – Design for disassembly design for recycle – Risk analysis – Material selection

UNIT – IV:
Eco design – Industrial Ecology – Pollution prevention – Reduction of toxic emissions and Emission less manufacturing.

UNIT – V:
Sustainable economic environment: Solar energy devices – wind energy resources – Full cost accounting methodology – Selection of natural friendly materials for green manufacturing.

TEXT BOOKS:
1. Dornfield David, Green Manufacturing, Springer, 2012
2. Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013

REFERENCES:
1. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.

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

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CO 1: Understand the concepts of green manufacturing.
CO 2: Illustrate various recycling techniques.
CO 3: Apply concepts of green design methods.
CO 4: Understand the concepts of eco design and emission less manufacturing.
CO 5: Apply concepts of the sustainable economic environment.

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HONORS		L	T	P	C
		4	0	0	4
ANALYSIS AND SYNTHESIS OF MECHANISMS					

Course Objectives:

1) To understand the general concepts of advanced kinematics of plane motion-I.
2) To apply the concepts of advanced kinematics of plane motion-II.
3) To understand the introduction to synthesis-graphical methods – I with function and path generation
4) To analyze the synthesis-graphical methods with Velocity – pole method and Roberts's theorem.
5) To illustrate the synthesis of four-bar mechanisms for prescribed extreme values of the angular velocity of driven link.

UNIT – I:

ADVANCED KINEMATICS OF PLANE MOTION- I: Introduction to plane motion. The Inflection circle, Euler – Savary Equation, Bobillier's Construction , Collinear axis , Hartmann's Construction ,Inflection circle for the relative motion of two moving planes, Application of the Inflection circle to kinematic analysis.

UNIT – II:

ADVANCED KINEMATICS OF PLANE MOTION – II: Polode curvature, Hall's Equation, Polode curvature in the four bar mechanism, coupler motion, relative motion of the output and input links, Determination of the output angular acceleration and its Rate of change, Freudenstein's collineation –axis theorem, Carter –Hall circle, The circling – point curve for the Coupler of a four bar mechanism.

UNIT – III:

INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS – I: The Four bar linkage ,Guiding a body through Two distinct positions, Guiding a body through Three distinct positions, The Roto center triangle , Guiding a body through Four distinct positions, Burmester's curve.

UNIT – IV:

INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS – II: Function generation-General discussion, Function generation: Relative – Roto center method, Overlay's method, Function generation- Velocity – pole method, Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

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UNIT – V:

INTRODUCTION TO SYNTHESIS – ANALYTICAL METHODS: Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation, Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition, Method of components, Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link, Method of components.

TEXT BOOKS:

1. Kinematics and Dynamics of plane mechanisms/ Jeremy Hirsch horn/McGraw-Hill.
2. Theory of Machines and Mechanisms/ J. E Shigley and J.J. Uicker Jr. / McGraw-Hill.

REFERENCES:

1. Design of machinery / Robert L Norton third edition/ McGraw-Hill 2004
2. Theory of Mechanisms and Machines/ Amitabh Ghosh and Ashok Kumar Mallik/ E. W. P. Publishers.
3. Kinematic Linkage Design/ Allen S.Hall Jr. / PHI.
4. Kinematics and Dynamics of Machinery/Charles E Wilson/Pearson/3rd Edition

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

CO 1: Understand the general concepts of advanced kinematics of plane motion-I.
CO 2: Apply the concepts of advanced kinematics of plane motion-II.
CO 3: Understand the introduction to synthesis-graphical methods – I with function and path generation..
CO 4: Analyze the synthesis-graphical methods with Velocity – pole method and Roberts's theorem.
CO 5: Illustrate the synthesis of four-bar mechanisms for prescribed extreme values of the angular velocity of driven link.

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HONORS		L	T	P	C
		4	0	0	4

ALTERNATIVE FUELS TECHNOLOGIES

Course Objectives: The Students will acquire the knowledge

1) To understand significance of fossil fuels and their limitations.
2) To apply the concepts of Methods of production of various liquid alternative fuels.
3) To identify different ways of using alternative liquid fuels in engines.
4) To illustrate the concepts of usage of gaseous fuels in alternative fuels technologies.
5) To understand principles of duel fuel combustion, hybrid power plants and fuel cell.

UNIT – I:
Fossil fuels and their limitations Engine requirements; Potential alternative liquid and gaseous fuels.

UNIT – II:
Methods of production; Properties, safety aspects, handling and distribution of various liquid alternative fuels like alcohols, vegetable oils, Di-methyl and Di-ethyl ether etc.

UNIT – III:
Different ways of using alternative liquid fuels in engines, performance and emission characteristics; Conversion of vegetable oils to their esters and effect on engine performance.

UNIT – IV:
Use of gaseous fuels like biogas, LPG, hydrogen, CNG, producer gas etc. in SI/CI engines; Production, storage, distribution and safety aspects of gaseous fuels

UNIT – V:
Different approaches like duel fuel combustion and surface ignition to use alternative fuels in engines; Use of additives to improve the performance with alternative fuels; Hybrid power plants and fuel cell.

TEXT BOOK:
1. Alternative Fuels: The Future of Hydrogen, Second Edition**,** Michael Frank Hordeski, CRC Press

REFERENCES:
1. Alternative Fuels for Transportation, A S Ramadhas, CRC Press
2. Alternative Fuels & Advanced Technology Vehicles: Incentives & Considerations, Thomas Huber, Jack Spera, Nova Science Publishers.

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KAKINADA–533003, Andhra Pradesh, India

DEPARTMENT OF MECHANICAL ENGINEERING

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

CO 1: Understand significance of fossil fuels and their limitations.
CO 2: Apply the concepts of methods of production of various liquid alternative fuels.
CO 3: Analyze different ways of using alternative liquid fuels in engines.
CO 4: Illustrate the concepts of usage of gaseous fuels in alternative fuels technologies.
CO 5: Understand principles of duel fuel combustion, hybrid power plants and fuel cell.

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
GEAR ENGINEERING					

Course Objectives:

1) To understand the Principles of gear tooth action and spur gears.
2) To illustrate the concepts of helical and bevel gears.
3) To interpret the design considerations and methodology of worm gear teeth and gear failures.
4) To analyze design of gear trains for various applications.
5) To understand the optimization of gear design parameters

UNIT – I:

Introduction: Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing processes and inspection, gear tooth failure modes, stresses, selection of right kind of gears.

Spur Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings, AGMA standards.

UNIT – II:

Helical Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings, AGMA standards.

Bevel Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

UNIT – III:

Worm Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Heat dissipation considerations. Design of gear shaft and bearings.

Gear failures: Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication failures

UNIT – IV:

Gear trains: Simple, compound and epicycle gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

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DEPARTMENT OF MECHANICAL ENGINEERING

UNIT – V:
Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques

TEXT BOOKS:
1. Maleev and Hartman, Machine Design, C.B.S. Publishers, India.
2. Henry E.Merrit, Gear engineering, Wheeler publishing, Allahabad, 1992.

REFERENCES:
1. Practical Gear design by Darle W. Dudley, McGraw-Hill
2. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York, 1949.
3. G.M.Maitha, Hand book of gear design, Tata McGraw Hill publishing company Ltd., New Delhi.

Course Outcomes: At the end of the course, student will be able to
CO 1: To understand the Principles of gear tooth action and spur gears.
CO 2: To illustrate the concepts of helical and bevel gears.
CO 3: To interpret the design considerations and methodology of worm gear teeth and gear failures.
CO 4: To analyze design of gear trains for various applications.
CO 5: To understand the optimization of gear design parameters.

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
EXPERIMENTAL METHODS IN FLUID MECHANICS					

Course Objectives:

1) To understand the general concepts of measurement systems and analysis of first order and second order measurement systems
2) To understand the operating principles and design considerations of various pressure measurement systems
3) To understand the operating principles and design considerations of various temperature measurement systems
4) To understand the operating principles and design considerations of various flow and velocity measurement systems
5) To understand working of different voltage indicating, recording and data acquisition systems

UNIT – I:

GENERAL CONCEPTS: Basic concepts of measurement methods, Sensing elements and transducers, Errors in instruments, Processing of experimental data, curve fitting and regression analysis.

ANALYSIS OF MEASUREMENT SYSTEMS

Analysis of First & Second order systems with examples of mechanical and thermal systems.

UNIT – II:

MEASUREMENT OF PRESSURE – Principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measurement –Manometers- Analysis of liquid manometer, dynamics of variable area and inclined manometer, Pressure transducers- Bellow gauges, Diaphragm gauges- Measurement of low pressure, Calibration methods, Dynamic characteristics, design principles.

UNIT – III:

TEMPERATURE MEASUREMENT: Different principles of Temperature Measurement, use of bimetallic thermometers ,Measurement Design, Construction and Analysis of liquid and gas thermometers, resistance thermometer with wheat stone bridge, Thermo-electric effect, Construction, testing and calibration of thermocouples and thermopiles, Thermistors, Pyrometers, measurement of heat flux, Calibration of temperature measuring instruments. Design of temperature measuring instruments

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UNIT – IV:
FLOW AND VELOCITY MEASUREMENT: Positive displacement methods, Obstruction meters, variable area meters, Ultrasonic flow meter, Vortex –shedding flow meters, Turbine meters, Thermal anemometers, Laser application in flow measurement calibration of flow measuring instruments. Introduction to design of flow measuring instruments. Velocity measurements- pitot tubes, yaw tubes, pitot static tubes, Laser Based Techniques.

UNIT – V:
VOLTAGE INDICATING, RECORDING AND DATA ACQUISITION SYSTEMS:
Standards and calibration, Analog volt meters and potentiometers. Electrical instruments. Digital voltmeters and multimeters. Signal generation. Electro mechanical servo type XT and XY recorders, Thermal array recorders and data acquisition systems. Analog and digital CROs. Displays and liquid crystals flat panel displays. Displays. Virtual instruments. Magnetic tape and disk recorders/reproducers. Fiber optic sensors.

TEXT BOOK:
Measurement System, Application & Design – E.O. Doeblin, MGH

REFERENCES:
1. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
2. Mechanical Measurements – Buck & Beckwith – Pearson.
3. Control Systems, Principles & Design, 2nd Edition – M. Gopal – TMH.
4. Mechanical Measurements – J.P Holman

Course Outcomes: At the end of the course, student will be able to
CO 1: Understand general concepts of measurement systems and analysis of first order and second order measurement systems
CO 2: Identify the operating principles and design considerations of various pressure measurement systems.
CO 3: Understands the operating principles and design considerations of various temperature measurement systems.
CO 4: Apply the operating principles and design considerations of various flow and velocity measurement systems
CO 5: Illustrate the working of different voltage indicating, recording and data acquisition systems.

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4

ADVANCED OPTIMIZATION TECHNIQUES

Course Objectives:

1) To understand the Engineering applications of optimization.
2) To apply the concepts of unconstrained optimization techniques.
3) To understand the concepts of constrained optimization techniques.
4) To solve geometric programming problems.
5) To solve multistage decision processes and dynamic programming problems.

UNIT – I:
INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.
CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints - multivariable optimization with inequality constraints..

UNIT – II:
UNCONSTRAINED OPTIMIZATION TECHNIQUES: pattern search method - Rosenbrock's method of rotating coordinates- the simplex method - Descent methods- gradient of function- steepest descent method.

UNIT – III:
CONSTRAINED OPTIMIZATION TECHNIQUES: characteristics of a constrained problem- methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT – IV:
GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P).Complimentary geometric programming (C.G.P).

UNIT – V:
DYNAMIC PROGRAMMING (D.P): Multistage decision processes. Concepts of sub optimization, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P., Continuous D.P.

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TEXT BOOK:
1. Optimization Theory and Applications, by S.S.Rao, Wiley Eastern Limited, New Delhi.

References:
1. Engineering Optimization by Kalyanmanai Deb, Prentice Hall of India, New Delhi.
2. Optimization Techniques, C.Mohan, Kusum Deep.
3. Operations Research by S.D.Sharma.

Course Outcomes: At the end of the course, student will be able to
CO 1: Understand the Engineering applications of optimization.
CO 2: Apply the concepts of unconstrained optimization techniques.
CO 3: Understand the concepts of constrained optimization techniques.
CO 4: Apply concepts of geometric programming problems.
CO 5: Analyze multistage decision processes and dynamic programming problems.

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
MICRO ELECTRO MECHANICAL SYSTEMS					

Course Objectives:

1) To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators
2) To illustrate thermal sensors and actuators used in MEMS.
3) To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
4) To analyze applications and considerations on micro fluidic systems.
5) To illustrate the principles of chemical and bio medical micro systems.

UNIT – I:

INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.

MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

UNIT – II:

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

UNIT – III:

MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

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UNIT – IV:
MICRO FLUIDIC SYSTEMS: Applications, considerations on micro scale fluid, fluid actuation methods, dielectro-phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps. RADIO FREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

UNIT – V:
CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.

TEXT BOOK:
1.MEMS, Nitaigour Premchand Mahalik, TMH

REFERENCE BOOKS:
1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. MEMS and NEMS, Sergey Edward Lyshevski, CRC Press, Indian Edition.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.
4. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.

Course Outcomes: At the end of the course, student will be able to
CO 1: To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.
CO 2: Illustrate thermal sensors and actuators used in MEMS.
CO 3: To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.
CO 4: Analyze applications and considerations on micro fluidic systems.
CO 5: Illustrate the principles of chemical and bio medical micro systems.

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HONORS		L	T	P	C
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TRIBOLOGY					

Course objectives:
1) To explain the contact of solid surfaces and types of lubrication
2) To understand the genesis of friction, the theories/laws of sliding and rolling friction
3) To apply the principles and design procedures for hydrostatic bearings.
4) To understand and analyze the principles of hydrodynamic and mixed/ boundary lubrication
5) To gain knowledge about the types of seals and failure of tribological components.

UNIT – I
Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.
Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection.

UNIT – II
Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

UNIT – III
Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness- journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.

UNIT – IV
Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum film thickness.

UNIT – V
Seals: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.
Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.
Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

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TEXT BOOKS:

1.Rowe WW& O' Dionoghue,"Hydrostatic and Hybrid bearing design " Butterworths & Co.Publishers Ltd,1983.
2.Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.
3. Bernard J.Hamrock, "Fundamentals of fluid film lubricant", McGraw-Hill Co., 1994.
4. Introduction to Tribology of bearings – B.C.Majumdar – S Chand Publishing.

REFERENCES:

1. Neale MJ, (Editor) "Tribology hand Book" NeumannButterworths, 1975.
2. Connor and Boyd JJO (Editors) "Standard hand book of lubrication engineers " ASLE, McGraw Hill Book & Co.,1968
3. Shigley J, E Charles, "Mechanical Engineering Design", McGraw Hill Co., 1989

COURSE OUTCOMES: Students will be able to

CO 1: Learn the concepts of surface topography and types of lubrication.
CO 2: Learn the genesis of friction, the theories/laws of sliding and rolling friction.
CO 3: Apply the principles and design procedures for hydrostatic bearings.
CO 4: Analyze the principles of hydrodynamic and mixed/ boundary lubrication.
CO 5: Gain knowledge about the types of seals and failure of tribological components.

HONORS		L	T	P	C

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DEPARTMENT OF MECHANICAL ENGINEERING					
			4	**0**	**0**	**4**
STATISTICAL DESIGN IN QUALITY CONTROL					

Course Objectives:

1) To Interpret quality engineering in production design, Loss Function and Quality Level in production process
2) To explain tolerance design for N-type. L-type and S-type characteristics and tolerance allocation
3) To interpret ANOVA techniques and need for ANOVA with multiple level factors.
4) To make use of orthogonal arrays for typical test strategies and interpolate experimental results
5) To explain six sigma DMAIC methodology and tools for process improvement in services and small organizations

UNIT – I:

QUALITY VALUE AND ENGINEERING: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type, S-type and L-type)

UNIT – II:

TOLERANCE DESIGN AND TOLERANCING: Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation for multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT – III:

ANALYSIS OF VARIANCE (ANOVA): Introduction to ANOVA, Need for ANOVA, NO way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT – IV:

ORTHOGONAL ARRAYS: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT – V:

SIX SIGMA AND THE TECHNICAL SYSTEM: Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

TEXT BOOKS:
Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.

REFERENCES:
1. Quality Engineering in Production systems by G. Taguchi, A. Elsayed et al, McGraw Hill Intl. Pub 1989.
2. Taguchi Methods explained: Practical steps to Robust Design / Papan P. Bagchi *I* Prentice Hall Pvt. Ltd. New Delhi

Course Outcomes: At the end of the course, student will be able to
CO 1: Interpret quality engineering in production design, Loss Function and Quality Level in production process
CO 2: Illustrate tolerance design for N-type. L-type and S-type characteristics and tolerance allocation.
CO 3: Interpret ANOVA techniques and need for ANOVA with multiple level factors.
CO 4: Make use of orthogonal arrays for typical test strategies and interpolate experimental results.
CO 5: Understand six sigma DMAIC methodology and tools for process improvement in services and small organizations

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
ADVANCED COMPUTATIONAL FLUID DYNAMICS					

Course objectives:
1) To understand the principles of various flows, finite difference and finite volume methods.
2) To apply the concepts of higher order upwind schemes for incompressible flow.
3) To apply the concepts of implicit methods for incompressible flow.
4) To understand and apply the concepts of compressible flow.
5) To model and simulate the turbulence.

UNIT-I
Introduction: Brief introduction of boundary layer flow, incompressible and compressible flows, finite difference and finite volume method, example of parabolic and hyperbolic systems and time discretization technique, explicit and implicit methods, upwind and central difference schemes, stability, dissipation and dispersion errors

UNIT-II
Incompressible Flow-1: Higher order upwind schemes: second order convective schemes, QUICK. Solution of NS equations: Solution of incompressible N-S equation (Explicit time stepping, Semi–explicit time stepping). SMAC method for staggered grid: Predictor - Corrector step, discretization of N-S and continuity equations, Pressure correction Poisson's equation, boundary conditions (no-slip, moving wall, slip boundary and inflow conditions), outflow (zero gradient/Orlanski) boundary conditions for unsteady flows, algorithm for the SMAC method, stability considerations for SMAC method.

UNIT-III
Incompressible Flow-2: Semi–implicit method (SIMPLE): Comparison with the SMAC and fully – implicit methods, algorithm for semi–implicit method, discussion on SIMPLE/SIMPLER and SIMPLEC. Discretization of governing equations and boundary conditions in FVM framework. SMAC method for collocated grid: Pressure–velocity coupling, N- S equations on a collocated grid, concept of momentum interpolation to avoid pressure velocity decoupling, discretization of governing equations using the concept of momentum interpolation

UNIT-IV
Compressible Flow: N-S and energy equations, properties of Euler equation, linearization. Solution of Euler equation: Explicit and implicit treatment such as Lax-Wendroff, McCormack, Beam and Warming schemes, Upwind schemes for Euler equation: Steger and Warming, Van Leer's flux splitting, Roe's approximate Riemann solver, TVD schemes. Solution of N-S equations: McCormack, Jameson algorithm in finite volume formulation and transformed coordinate system

UNIT-V

Turbulence modelling: Introduction to turbulence, scales of turbulence, Reynolds Averaged Navier Stokes (RANS) equation, closure problem, eddy viscosity model, k-ε and k-ω model, introduction to large eddy simulation (LES) and direct numerical simulation.

TEXT BOOKS:

1. Computational Fluid Flow and Heat Transfer, Second Edition by K. Muralidhar, T. Sundararajan (Narosa), 2011.
2. Computational Fluid Dynamics by Chung T. J., Cambridge University Press, 2003.
3. Computational Fluid Dynamics by Tapan K. Sengupta, University Press, 2005.
4. Numerical Computation of Internal and External Flows by Hirch C., Elsevier 2007.

REFERENCES:

1. Numerical Heat Transfer and Fluid Flow by S. V. Patankar (Hemisphere Series on Computational Methods in Mechanics and Thermal Science)
2. Essential Computational Fluid Dynamics by Zikanov. O., Wiley 2010.
3. Computer Simulation of Flow and Heat Transfer by P. S. Ghoshdastidar (4th Edition, Tata McGraw-Hill), 1998

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

CO1: Learn the principles of various flows, finite difference and finite volume methods
CO2: Learn the concepts of higher order upwind schemes for incompressible flow.
CO3: Analyze the implicit methods for incompressible flow.
CO4: Apply the concepts of compressible flow.
CO5: Model and simulate the turbulence.

HONORS		L	T	P	C
		4	0	0	4
MATERIALS CHARACTERIZATION TECHNIQUES					

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DEPARTMENT OF MECHANICAL ENGINEERING

Course Objectives:

1) To understand the various structure analysis tools like X-ray diffraction
2) To apply the microscopy techniques for materials characterization.
3) To understand the concepts of thermal analysis techniques.
4) To learn about the magnetic characterization techniques.
5) To illustrate optical and electronic characterization techniques.

UNIT – 1

Introduction to materials and Techniques: Structure analysis tools: X-ray diffraction: phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction.

UNIT – 2

Microscopy techniques: Optical microscopy, analysis transmission electron microscopy (TEM), energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), atomic force microscopy (AFM) and scanning probe microscopy (SPM), quantitative metallography.

UNIT – 3

Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimeter (DSC), Thermo gravimetric analysis (TGA); Electrical characterization techniques: Electrical resistivity, Hall effect, Magneto resistance.

UNIT – 4

Magnetic characterization techniques: Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance

UNIT – 5

Optical and electronic characterization techniques: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

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TEXT BOOKS:

1. Characterization of Materials (Materials Science and Technology: A Comprehensive Treatment, Vol 2A & 2B
2. Semiconductor Material and Device Characterization, 3rdEdition, D. K. Schroder, Wiley-IEEE Press (2006).
3. Materials Characterization Techniques, S Zhang, L. Li and Ashok Kumar, CRC Press (2008).

REFERENCES:

1. Physical methods for Materials Characterization, P. E. J.Flewitt and R K Wild, IOP publishing (2003).
2. Characterization of Nano - phase materials, Ed. Z L Wang, Willet-VCH (2000).

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

CO1: Understand the various structure analysis tools

CO2: Apply microscopic techniques for material characterization.

CO3: Learn about thermal analysis techniques.

CO4: Understand magnetic characterization techniques

CO5: Learn about optical and electronic characterization techniques.

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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
PRODUCT DESIGN					

Course Objectives:

1. To understand the basic concepts of product design process
2. To interpret the operations of product management and impact of manufacturing processes on product decisions
3. To understand concepts of risks and reliability.
4. To interpret the various testing procedure of the product design.
5. To understand the concepts of maintainability.

UNIT – 1

Product Design Process: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees. Modelling and Simulation: Triz, Role of Models in Engineering Design, Mathematical Modelling, Similitude and Scale Models, Computer Simulation, Geometric Modelling on Computer, Finite-Element Analysis.

UNIT – 2

Product management: The operation of product management: Customer focus of product management, product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.
Product development: Managing new products, Generating ideas, Sources of product innovation, selecting the best ideas, the political dimension of product design, Managing the product launch and customer feedback.
Product managers and manufacturing: The need for effective relationships, The impact of manufacturing processes on product decisions, Prototype planning,, Productivity potentials, Management of product quality, Customer service levels.

UNIT – 3

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

UNIT – 4

Product Testing; Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data

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UNIT – 5 DEPARTMENT OF MECHANICAL ENGINEERING

Design For Maintainability: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs. Design Standardization and Cost Reduction: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

TEXT BOOKS:

1. Engineering Design, George E. Dieter, McGraw-Hill
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer

REFERENCES:

1. The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
2. New Product Design, Ulrich Eppinger,
3. Product Design, Kevin Otto.

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

CO1: Understand the basic concepts of product design process
CO2: Identify the operations of product management and impact of manufacturing processes on product decisions
CO3: Understand concepts of risks and reliability of the products design
CO4: Interpret the various testing procedure of the product design.
CO5: Illustrate the concepts of maintainability.

HONORS		L	T	P	C
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ELECTRIC AND HYBRID VEHICLES					

Course objectives: To

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1) Understand electric vehicle & HEV for various applications
2) Have knowledge about the electric vehicle system and its parameters
3) Learn about EV motor drives
4) Understand the concepts of HEV
5) Learn about the energy sources, battery chargers and charging infrastructure.

UNIT – I

Introduction to EV & HEV: Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine.

UNIT – II

EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drives, In-wheel drives

EV Parameters: Weight, size, force, energy & performance parameters.

UNIT – III

EV Motor Drive:

DC Motor: Type of wound-field DC Motor, Torque speed characteristics, DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor

Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control

UNIT – IV

HEV: HEV, Energy Sources & Charging HEV: Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance

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UNIT – V

Energy Sources: Different Batteries, Battery characteristics (Discharging & Charging)

Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.

Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

TEXT BOOKS:

1) C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.
2) Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

REFERENCE BOOKS:

1) Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2) James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

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

CO1: Understand electric vehicle & HEV for various applications

CO2: Have knowledge about the electric vehicle system and its parameters

CO3: Learn about EV motor drives

CO4: Understand the concepts of HEV.

CO5: Learn about the energy sources, battery chargers and charging infrastructure.

HONORS		L	T	P	C

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DEPARTMENT OF MECHANICAL ENGINEERING				
	4	**0**	**0**	**4**
MECHANICAL VIBRATIONS AND ACCOUSTICS				

Course objectives:

1) To understand the basic concepts and behavior of vibrations in machines
2) To understand the determination of frequencies and other parameters in multi degree vibration systems
3) To understand to behavior of continuous systems
4) To understand the basic concepts of acoustics
5) To understand the principles of noise measuring instruments

UNIT-I:

INTRODUCTION: Relevance of and need for vibration analysis – Basics of SHM - Mathematical modeling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

UNIT-II:

MULTI DEGREE FREEDOM SYSTEMS: Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - orthogonality principle-Energy methods, Eigen values and Eigen vectors

UNIT-III:

CONTINUOUS SYSTEMS: Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams - Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non-linear and random vibrations.

UNIT-IV:

BASICS OF ACOUSTICS: Speed of Sound, Wavelength, Frequency, and Wave Number, Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Wave propagation, Directivity Factor and Directivity Index, Levels and the Decibel, Addition and subtraction of Sound levels, Octave Bands, Weighted Sound Levels.

UNIT-V:

NOISE MEASUREMENT AND CONTROL: Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic analyzers, Dosimeter, Measurement of Sound Power, impact of noise on humans, A-Weighting, Noise control strategy, sound absorption and insulation.

TEXT BOOKS:

1. S.S.Rao, “Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
2. L.Meirovitch, “Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985.

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REFERENCES:

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, "Theory of Vibration with Applications", 5th Edition, Pearson Education, 2008.
2. M.L.Munjal, "Noise and Vibration Control", World Scientific, 2013.
3. Beranek and Ver, "Noise and Vibration Control Engineering: Principles and Applications", John Wiley and Sons, 2006.
4. Randall F. Barron, "Industrial Noise Control and Acoustics", Marcel Dekker, Inc., 2003

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

CO1: Learn about the basic concepts and behavior of vibrations in machines
CO2: Analyze the machine vibrations in multi degree of freedom systems
CO3: Apply the torsional vibration concepts to the continuous systems
CO4: Learn about the basic concepts of acoustics
CO5: Utilize the noise measuring instruments

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HONORS		L	T	P	C
		4	0	0	4
ADVANCED THERMODYNAMICS					

Course Objectives:
1) To understand the thermodynamic laws and corollaries.
2) To illustrate the concepts of real gas behavior
3) To apply the general concepts of combustion
4) To analyze power cycles
5) To illustrate the working principles of direct energy conversion techniques.

UNIT – 1
REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES: Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance

UNIT – 2
P.V.T SURFACE: Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius-Clapeyron equation. Throttling, Joule Thomson coefficient.

UNIT – 3
COMBUSTION: Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gases, Effect of non-reacting gases equilibrium in multiple reactions, The vent Hoff's equation - Gibbs phase rule.

UNIT – 4
POWER CYCLES: Review binary vapor cycle, co-generation and combined cycles, Second law analysis of cycles. Refrigeration cycles. Thermodynamics off irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

UNIT – 5
DIRECT ENERGY CONVERSION INTRODUCTION: Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells

TEXT BOOKS:

1. Basic and Applied Thermodynamics/P.K. Nag/TMH.
2. Thermodynamics/Holman/ Mc Graw Hill.

REFERENCES

1. Engineering Thermodynamics/PL. Dhār / Elsevier
2. Thermodynamics/Sonntag & Van Wylen / John Wiley & Sons
3. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons
4. Irreversible thermodynamics/HR De Groff.
5. Thermal Engineering / Soman / PHI
6. Thermal Engineering / Rathore / TMH
7. Engineering Thermodynamics/Chatopadyaya/

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

CO1: Understand the thermodynamic laws and corollaries.

CO2: Illustrate the concepts of real gas behavior

CO3: Apply the general concepts of combustion reactions and chemical equilibrium of ideal gases.

CO4: Analyze power cycles.

CO5: Apply the working principles of direct energy conversion techniques.

		L	T	P	C
HONORS		**4**	**0**	**0**	**4**

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DESIGN FOR MANUFACTURING AND ASSEMBLY

Course Objectives: The students will acquire the knowledge:

1) To understand the basic concepts of design for manual assembly
2) To interpret basic design procedure of machining processes
3) To understand design considerations metal casting, extrusion and sheet metal work
4) To interpret the design considerations of various metal joining process.
5) To interpret the basic design concepts involved in the assembly automation

UNIT – 1

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design? Typical DFMA Case Studies, 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 – 2

Machining processes: Overview of various machining processes-general design rules for machining dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT – 3

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.

Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, and deep drawing-Keeler Goodman forging line diagram – component design for blanking

UNIT – 4

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies –drop forging die design – general design recommendations.

UNIT – 5

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices

used in automated assembly systems, Quantitative analysis of assembly systems, Multi station assembly systems, and single station assembly lines.

Design for Additive Manufacturing: Design considerations, allowances

TEXT BOOKS:

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture by Boothroyd,
3. Design for manufacture, James Bralla

REFERENCE:

1. ASM Hand book Vol.20

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

CO1: Understand the basic concepts of design for manual assembly
CO2: Identify basic design procedure of various machining processes.
CO3: Illustrate the design considerations metal casting, extrusion and sheet metal work
CO4: Interpret the design considerations of various metal joining process.
CO5: Understand the basic design concepts involved in the assembly automation

HONORS		L	T	P	C
		4	0	0	4
ROBOTICS AND CONTROL					

Course Objectives:

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1) To demonstrate the concepts of motion controllers, Actuation and feedback components
2) To interpret the sensing and Digitizing-imaging devices, image processing and analysis on image data reduction, feature extraction and Object recognition
3) To classify generations of robot programming languages, Robot language structures, their elements and function
4) To make use of AML language basic commands
5) To explain Robot cell design and control and practical study of virtual robot

UNIT – 1

INTRODUCTION: **CONTROL SYSTEM AND COMPONENTS:** Basic concepts and motion controllers, control system analysis, robot actuation and feedback components, control systems and dynamic performance, precision of movement.

SENSORS: Desirable features, tactile, proximity and range sensors, uses of sensors in robotics. Positions sensors, velocity sensors

UNIT – 2

MACHINE VISION: Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition. Training the vision system, Robotic application.

UNIT – 3

ROBOT PROGRAMMING: Textual robot Languages, Generations of robot programming languages, Robot language structures, Elements and function. VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program

UNIT – 4

AML LANGUAGE-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing

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UNIT – 5

ROBOT CELL DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller.

PRACTICAL STUDY OF VIRTUAL ROBOT: Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, work planning, program modules, input and output signals – Singularities - Collision detection-Repeatability measurement of robot-Robot economics.

TEXT BOOKS:

1. Industrial Robotics / Grover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.

REFERENCES:

1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall
3. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
4. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley
5. Introduction to Robotics by SK Saha, the McGraw Hill Company, 6th, 2012
6. Robotics and Control / Mittal R K & Nagrath I J / TMH

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

CO1: Demonstrate basic concepts of motion controllers, robot actuation and feedback components
CO2: Interpret the sensing and Digitizing-imaging devices, image processing and analysis on image data reduction, feature extraction and Object recognition
CO3: Classify generations of robot programming languages, Robot language structures, their elements and function
CO4: Make use of AML Language
CO5: Explain Robot cell design and control and practical study of virtual robot

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HONORS		L	T	P	C
		4	0	0	4
TURBO MACHINES					

Course Objectives:

1) To learn basic concepts of turbo machines
2) To learn the thermal analysis of steam nozzles and steam turbines
3) To learn the basic concepts of gas dynamics and centrifugal compressor
4) To learn the basic concepts of cascade analysis and axial compressors
5) To learn the concepts of axial flow gas turbines

UNIT – 1

FUNDAMENTALS OF TURBO MACHINES: Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines

UNIT – 2

STEAM NOZZLES: Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of back pressure of analysis. Designs of nozzles.

Steam Turbines: Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

UNIT – 3

GAS DYNAMICS: Fundamental thermodynamic concepts, isentropic conditions, mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, Detached shocks, Aerofoil theory.

Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT – 4

AXIAL FLOW COMPRESSORS: Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance

Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

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UNIT – 5

AXIAL FLOW GAS TURBINES: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

TEXT BOOK:

1. Principles of Turbo Machines/DG Shepherd / Macmillan

REFERENCES:

1. Fundamentals of Turbo machinery/William W Perg/John Wiley & Sons
2. Element of Gas Dynamics/Yahya/TMH
3. 3. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/New York
4. Turbines, Pumps, Compressors/Yahya/TMH
5. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
6. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications

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

CO1: Illustrate the concepts of turbo machines.
CO2: Analyze the thermal analysis of steam nozzles and steam turbines
CO3: Build the concepts of gas dynamics and centrifugal compressor
CO4: Build the concepts of cascade analysis and axial compressors
CO5: Understand the concepts axial flow gas turbines

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DEPARTMENT OF MECHANICAL ENGINEERING		**L**	**T**	**P**	**C**
HONORS		**4**	**0**	**0**	**4**
MATERIALS TECHNOLOGY					

Course objectives:

1) To understand the concepts of different strengthening mechanisms and plastic behaviour of engineering materials.
2) To understand the principles of deformation and fracture mechanism.
3) To understand and analyze the concepts of fatigue and fracture of non-metallic materials.
4) To do appropriate selection of modern metallic materials for various engineering applications.
5) To gain knowledge about the non-metallic materials and applications.

UNIT - I

ELASTICITY IN METALS: Mechanism of plastic deformation, slip and twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behaviour, super plasticity, Yield criteria: Von-mises and Tresca criteria.

UNIT - II

FRACTURE: Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture,

CREEP: Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT - III

Fatigue, fatigue limit, features of fatigue fracture, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue.

UNIT - IV

MODERN METALLIC MATERIALS: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallic, Ni and Ti Aluminides. Processing and applications of Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials.

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UNIT - V

NON-METALLIC MATERIALS: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, $A1_2O_3$, SiC, Si_3N_4, CBN and Diamond – properties, Processing and applications.

TEXT BOOKS:

1. Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/ 2nd Edition/2000
2. Mechanical Metallurgy/George E. Dieter/McGraw Hill, 1998..

REFERENCES:

1 Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2 Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson
3 Material Science and Engineering/William D Callister/John Wiley and Sons
4 Plasticity and plastic deformation by Aritzur.
5 Introduction to Ceramics, 2nd Edition by W. David Kingery, H. K. Bowen, Donald R. Uhlmann

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

CO1: Learn the concepts of different strengthening mechanisms and plastic behaviour of engineering materials.
CO2: Learn the principles of deformation and fracture mechanism.
CO3: Analyze the concepts of fatigue and fracture of non-metallic materials.
CO4: Select the modern metallic materials for various engineering applications.
CO5: Gain knowledge about the non-metallic materials and applications.