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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II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC-5	Vector Calculus, Fourier Transforms and PDE(M-III)	3	0	0	3
2	PCC-1	Mechanics of Solids	3	0	0	3
3	PCC-2	Fluid Mechanics & Hydraulic Machines	3	0	0	3
4	PCC-3	Production Technology	3	0	0	3
5	PCC-4	Kinematics of Machinery	3	0	0	3
6	PCC-L1	Computer Aided Engineering Drawing Practice	0	0	3	1.5
7	PCC-L2	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
8	PCC-L3	Production Technology Lab	0	0	3	1.5
9	SOC-1	Drafting and Modeling Lab	0	0	4	2
10	MC-3	Essence of Indian Traditional Knowledge	2	0	0	0
		Total Credits				**21.5**

II YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	ESC-6	Material Science & Metallurgy	3	0	0	3
2	BSC-6	Complex Variables and Statistical Methods	3	0	0	3
3	PCC-5	Dynamics of Machinery	3	0	0	3
4	PCC-6	Thermal Engineering-I	3	0	0	3
5	HSC-2	Industrial Engineering and Management	3	0	0	3
6	ESC-L4	Mechanics of Solids and Metallurgy Lab	0	0	3	1.5
7	PCC-L6	Machine Drawing Practice	0	0	3	1.5
8	PCC-L7	Theory of Machines Lab	0	0	3	1.5
9	SOC-2	Python Programming Lab	1	0	2	2
		Total Credits				**21.5**
Honors/Minor courses			**4**	**0**	**0**	**4**

* At the end of II Year II Semester, students must complete summer internship spanning between 1 to 2 months (Minimum of 6 weeks), @ Industries/ Higher Learning Institutions/ APSSDC.

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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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DEPARTMENT OF MECHANICAL ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
VECTOR CALCULUS FOURIER TRANSFORMS and PDE (M-III)					

Course Objectives:
- To familiarize the techniques in partial differential equations
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

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

- interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- estimate the work done against a field, circulation and flux using vector calculus (L5)
- apply the Laplace transform for solving differential equations (L3)
- find or compute the Fourier series of periodic signals (L3)
- know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)
- identify solution methods for partial differential equations that model physical processes (L3)

UNIT –I: Vector calculus: **(10hrs)**
Vector Differentiation: Gradient– Directional derivative – Divergence– Curl– Scalar Potential.
Vector Integration: Line integral – Work done – Area– Surface and volume integrals – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and problems on above theorems.

UNIT –II: Laplace Transforms: **(10 hrs)**
Laplace transforms – Definition and Laplace transforms of some certain functions– Shifting theorems – Transforms of derivatives and integrals – Unit step function –Dirac's delta functionPeriodic function – Inverse Laplace transforms– Convolution theorem (with out proof).
Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

UNIT –III: Fourier series and Fourier Transforms: **(10 hrs)**
Fourier Series: Introduction– Periodic functions – Fourier series of periodic function –Dirichlet's conditions – Even and odd functions –Change of interval– Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Sine and cosine transforms – Properties (article-22.5 in text book-1)– inverse transforms – Convolution theorem (without proof) – Finite Fourier transforms.

UNIT –IV: PDE of first order: **(8hrs)**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

UNIT – V: Second order PDE and Applications: **(10 hrs)**
Second order PDE: Solutions of linear partial differential equations with constant coefficients –Non-homogeneous term of the type e^{ax+by}, $\sin(ax+by)$, $\cos(ax+by)$, $x^m y^n$.

Applications of PDE: Method of separation of Variables– Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **B. V. Ramana,**Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **Dean. G. Duffy,** Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press.
3. **Peter O' Neil,** Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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II Year - I Semester		L	T	P	C
		3	0	0	3
MECHANICS OF SOLIDS					

Course Objectives: The students completing this course are expected to understand the basic terms like stress, strain, poissons ratio…etc and different stresses and deflections induced in beams, thin cylinders, thick cylinders, and columns. Further, the student shall be able to understand the shear stresses due to torsion in circular shafts.

UNIT – I

SIMPLE STRESSES &STRAINS : Elasticity and plasticity – Types of stresses & strains– Hooke'slaw – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT – II

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

UNIT – III

FLEXURAL STRESSES : Theory of simple bending – Assumptions – Derivation of bending equation: M/ I = f/y = E/R Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Designof simple beam sections.

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

UNIT – IV

DEFLECTION OF BEAMS : Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, Statically indeterminate Beams and solutionmethods.

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

UNIT – V

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

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

TEXT BOOKS:

1. Strength of materials /GH Ryder/ Mc Millan publishers IndiaLtd.
2. Strength of materials by B.C. Punmia-lakshmi publications pvt.Ltd, NewDelhi.

REFERENCES:

1. Mechanics of Materials by Gere &Timeshenko
2. Strength of Materials -By Jindal, UmeshPublications.
3. Strength of Materials by S.Timshenko- D. VAN NOSTRAND Company- PHIPublishers
4. Strength of Materials by Andrew Pytel and Ferdinond L. Singer Longman-HarpercollinsCollege Division
5. Solid Mechanics, byPopov-
6. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

Course outcomes:

On the completion of the course the student will able to

CO1: Model & Analyze the behavior of basic structural members subjected to various loading and support conditions based on principles of equilibrium.
CO2: Understand the apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
CO3: Students will learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams forbeams.
CO4: Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
CO5: Design and analysis of Industrial components like pressure vessels.

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DEPARTMENT OF MECHANICAL ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
FLUID MECHANICS & HYDRAULIC MACHINES					

Course Objectives: The students completing this course are expected to understand the properties of fluids, its kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations. Further, the student shall be able to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

UNIT I

Objective: After studying this unit student will know the concept of fluid and its properties, manometry, hydrostatic forces acting on different surfaces and also problem solving techniques.

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.

UNIT II

Objective: In this unit student will be exposed to the basic laws of fluids, flow patterns, viscous flow through ducts and their corresponding problems.

Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flow net, source and sink, doublet and vortexflow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipebend.

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line.

UNIT III

Objective: At the end of this unit student will be aware of the concepts related to boundary layer theory, flow separation, basic concepts of velocity profiles, dimensionless numbers and dimensional analysis.

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT IV

Objective: In this unit student will know the hydrodynamic forces acting on vanes and performance evaluation of hydraulic turbines.

Basics of turbo machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radialvanes.

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – draft tube- theory- functions andefficiency.

UNIT V

Objective: After studying this unit student will be in a position to understand the characteristic curves of hydraulic turbines and also *evaluate the performance characteristics of hydraulic pumps.*

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

Centrifugalpumps: classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH. **Reciprocating pumps:** Working, Discharge, slip, indicatordiagrams.

TEXT BOOKS:

1. Fluid Mechanics- Fundementals and Applications by Y.A. Cengel, J.M.Cimbala, 6thEdn,McGrawHill
2. Fluid Mechanics - Dixon, 7thEdn,Elesvier

REFERENCE BOOKS:

1. Hydraulics, fluid mechanics and Hydraulic machinery- Modi andSeth
2. Fluid Mechanics and Hydraulic Machines - RK Bansal- Laxmi Publications (P)Ltd.
3. Fluid Mechanics and Hydraulic Machines –Rajput
4. Fluid Mechanics and Fluid Power Engineering - D.S. Kumar, Kotaria&Sons.
5. Fluid Mechanics and Machinery - D. Rama Durgaiah, New AgeInternational.

COURSE OUTCOMES:

From this course the student is expected to learn
CO1: The basic concepts of fluid properties.
CO2: The mechanics of fluids in static and dynamic conditions.
CO3: Boundary layer theory, flow separation and dimensional analysis. CO4: Hydrodynamic forces of jet on vanes in different positions.
CO5: Working Principles and performance evaluation of hydraulic pump and turbines.

II Year - I Semester		L	T	P	C
		3	0	0	3
PRODUCTION TECHNOLOGY					

Course Objective:
To impart basic knowledge and understanding about the primary manufacturing processes such as casting, joining, bulk forming, sheet metal forming and powder metallurgy and their relevance in current manufacturingindustry.

UNIT – I
CASTING: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding – molding methods - ingredients of molding sand –. Molding materials, Properties of molding sand, Testing of molding sand. Types of molding – Hand molding – Machine molding. Core – different types of cores – materials – properties of core sand – core manufacturing.

UNIT – II
Principles of Gating, Gating ratio and design of Gating systems. Risers – Types, function and design, casting design considerations. Methods of melting and types of furnaces - cupola, electric arc, resistance and induction furnace. Solidification of castings-Solidification of pure metals and alloys-Short & long freezing range alloys. Fettling. Casting defects. Basic principles and applications of special casting processes - Centrifugal casting – True, semi and centrifuging, Die casting, Investment casting and shell molding.

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.
Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing.
Heat affected zones in welding; pre & post heating, Weldability of metals, welding defects – causes and remedies – destructive and nondestructive testing of welds.

UNIT – IV
Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging - Types of Forging, 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 ofpresses and presstools.

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

TEXT BOOKS:

1. Manufacturing Processes for Engineering Materials – Kalpakjian S and Steven RSchmid- Pearson Publ , 5thEdn.
2. Manufacturing Technology -Vol I- P.N. Rao-TMH

REFERENCES:

1. Manufacturing Science – A.Ghosh&A.K.Malik – East West Press Pvt.Ltd
2. Process and materials of manufacture- Lindberg-PHI
3. Production Technology- R.K. Jain-Khanna
4. Production Technology-P C Sharma-S.Chand
5. Manufacturing Processes- H.S. Shaun-Pearson
6. Manufacturing Processes- J.P. Kaushish-PHI
7. Workshop Technology -WAJ Chapman/CBS Publishers&DistributorsPvt.Ltd.
8. Production Technology-HMT- TataMcGrawHill

Course Outcomes:

CO1: Able to design the patterns and core boxes for metal casting processes
CO2: Able to design the gating system for different metallic components
CO3: Know the different types of manufacturing processes
CO4: Be able to use forging, extrusion processes
CO5: Learn about the different types of welding processes used for special fabrication.

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DEPARTMENT OF MECHANICAL ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
KINEMATICS OF MACHINERY					

Course objective: The students completing this course are expected to understand the nature and role of the kinematics of machinery, mechanisms and machines. The course includes velocity and acceleration diagrams, analysis of mechanisms joints, Cams and their applications. It exposes the students to various kinds of power transmission devices like belt, rope, chain and gear drives and their working principles and their merits and demerits.

UNIT – I

MECHANISMS : Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained.

Grashoff'slaw , Degrees of freedom ,Kutzbachcriterian for planar mechanisms, Mechanism and machines – classification of machines – kinematic chain – inversion of mechanism – inversions of quadric cycle chain – single and double slider crankchains.

UNIT – II

LOWER PAIR MECHANISM: Exact and approximate copiers and generated types – Peaucellier, Hart and Scott Russul – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and straight line motion, Pantograph.

Conditions for correct steering – Davis Steering gear, Ackermans steering gear – velocity ratio; Hooke's Joint: Single and double – Universal coupling–application–problems.

UNIT – III

KINEMATICS: Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of for a given mechanism, Klein's construction, determination of Coriolis component of acceleration.

PLANE MOTION OF BODY: Instantaneous center of rotation, centroids and axodes – relative motion between two bodies – Three centres in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

UNIT – IV

CAMS: Definitions of cam and followers – their uses – Types of followers and cams – Terminology – Types of follower motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3cases.

Analysis of motion of followers: Roller follower – circular cam with straight, concave and convex flanks.

BELT DRIVES: Introduction, Belt and rope drives, selection of belt drive- types of belt drives,V-belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, Chains-length, angular speed ratio, classification of chains.

UNIT – V

GEARS: Higher pairs, friction wheels and toothed gears–types – law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact – Introduction to Helical, Bevel and worm gearing.

GEAR TRAINS: Introduction to gear Trains, Train value, Types – Simple and reverted wheel train – Epicyclic gear Train. Methods of finding train value or velocity ratio – Epicyclic gear trains. Selection of gear box-Differential gear for an automobile.

TEXT BOOKS:

1. Theory of Mechanisms & Machines by Jagadeesh lal, Metropolitan Pvt. Ltd.
2. Theory of Machines by Thomas Bevan/ CBS Publishers

REFERENCES:

1. Theory of Machines – S. S Rattan- TMH Publishers
2. Theory of machines and Machinery-Vickers - Oxford.
3. Theory of Mechanisms and machines – A.Ghosh&A.K.Malik – East West Press Pvt.Ltd.
4. Kinematics and dynamics of Machinery- R.L Norton- TATAMcGraw-Hill

Course outcomes:

The student should be able to

CO1: Contrive a mechanism for a given plane motion with single degree of freedom.

CO2: Suggest and analyze a mechanism for a given straight line motion and automobile steering motion. CO3: Analyze the motion (velocity and acceleration) of a plane mechanism.

CO4: Suggest and analyze mechanisms for a prescribed intermittent motion like opening and closing of IC engine valves etc.

CO5: Select a power transmission system for a given application and analyze motion of different transmission systems

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II Year - I Semester		L	T	P	C
		0	0	3	1.5
COMPUTER AIDED ENGINEERING DRAWING PRACTICE					

Course Objective: To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing andmodeling.

UNIT-I:

Objective: The knowledge of projections of solids is essential in 3D modeling and animation. The student will be able to draw projections of solids. The objective is to enhance the skills they already acquired in their earlier course in drawing ofprojection.

PROJECTIONS OF SOLIDS: Projections of Regular Solids inclined to both planes – Auxiliary Views.

UNIT-II:

The knowledge of sections of solids and development of surfaces is required in designing and manufacturing of the objects. Whenever two or more solids combine, a definite curve is seen at their intersection.

SECTIONS OF SOLIDS: Sections and Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views.

DEVELOPMENT AND INTERPENETRATION OF SOLIDS: Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid, Cone and their parts.

UNIT-III:

The intersection of solids also plays an important role in designing and manufacturing. The objective is to impart this knowledge through this topic. A perspective view provides a realistic 3D View of an object. The objective is to make the students learn the methods of Iso and Perspective views.

INTERPENETRATION OF RIGHT REGULAR SOLIDS: Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs Cone, Prism Vs Cone.

PERSPECTIVE PROJECTIONS: Perspective View: Points, Lines, Plane Figures and Simple Solids, Vanishing Point Methods (General Method only).

In part B computer aided drafting is introduced.

UNIT IV:

The objective is to introduce various commands in AutoCAD to draw the geometric entities and to create 2D and 3D wire frame models.

INTRODUCTION TO COMPUTER AIDED DRAFTING: Generation of points, lines, curves, polygons, dimensioning. Types of modeling : object selection commands – edit, zoom, cross hatching, pattern filling, utility commands, 2D wire frame modeling, 3D wire frame modeling,.

UNIT V:

By going through this topic the student will be able to understand the paper-space environment thoroughly.

VIEW POINTS AND VIEW PORTS: view point coordinates and view(s) displayed, examples to exercise different options like save, restore, delete , joint , single option.

UNIT VI:

The objective is to make the students create geometrical model of simple solids and machine parts and display the same as an Isometric, Orthographic or Perspective projection.
COMPUTER AIDED SOLID MODELING: Isometric projections, orthographic projections of isometric projections, Modeling of simple solids, Modeling of Machines & Machine Parts.

TEXT BOOKS:

1. Engineering drawing by N.D Bhatt ,Charotarpublications.
2. Engineering Graphics, K.C. john, PHIPublications

REFERENCES:

1. Mastering Auto CAD 2013 and Auto CAD LT 2013 – George Omura,Sybex
2. Auto CAD 2013 fundamentals- Elisemoss, SDCPubl.
3. Engineering Drawing and Graphics using Auto Cad – T Jeyapoovan,vikas
4. Engineering Drawing + AutoCAD – K Venugopal, V. Prabhu Raja, NewAge
5. Engineering Drawing – RK Dhawan, SChand
6. Engineering Drawing – MB Shaw, BC Rana,Pearson
7. Engineering Drawing – KL Narayana, P Kannaiah,Scitech
8. Engineering Drawing – Agarwal and Agarwal, Mc GrawHill
9. Engineering Graphics – PI Varghese, Mc GrawHill
10. Text book of Engineering Drawing with auto-CAD ,K.venkatareddy/B.S .publications.
11. Engineering Drawing with Auto CAD/ James D Bethune/Pearson Publications
12. Engineering Graphics with Auto CAD/Kulkarni D.M, Rastogi A.P, Sarkar A.K/PHI Publications

End Semester examination shall be conducted for **Four** hours with the followingpattern:

a) Two hours - Conventionaldrawing
b) Two hours – Computer AidedDrawing

Course outcomes:

1. Student get exposed on working of sheet metal with help of development ofsurfaces.
2. Student understands how to know the hidden details of machine components with the help of sections and interpenetrations ofsolids.
3. Student shall exposed to modeling commands for generating 2D and 3D objects using computer aided drafting tools which are useful to create machine elements for computeraidedanalysis.

II Year - I Semester		L	T	P	C
		0	0	3	1.5
FLUID MECHANICS & HYDRAULIC MACHINERY LAB					

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

1. Impact of jets onVanes.
2. Performance Test on PeltonWheel.
3. Performance Test on FrancisTurbine.
4. Performance Test on KaplanTurbine.
5. Performance Test on Single Stage CentrifugalPump.
6. Performance Test on Multi Stage CentrifugalPump.
7. Performance Test on ReciprocatingPump.
8. Calibration ofVenturimeter.
9. Calibration of Orificemeter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in apipeline.
12. Turbine flowmeter.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

II Year - I Semester		L	T	P	C
		0	0	3	1.5
PRODUCTION TECHNOLOGY LAB					

Course Objective: To impart hands-on practical exposure on manufacturing processes and equipment.

1. Design and making ofpattern
   i. Single piecepattern
   ii. Splitpattern
2. Sand propertiestesting
   i. Sieve analysis (drysand)
   ii. Clay contenttest
   iii. Moisture contenttest
   iv. Strength test (Compression test & Sheartest)
   v. Permeabilitytest
3. Mouldpreparation
   i. Straightpipe
   ii. Bentpipe
   iii. Dumbleiv.Gearblank
4. Gas cutting andwelding
5. Manual metal arcwelding
   i. Lapjoint
   ii. Buttjoint
6. InjectionMolding
7. Blow Molding
8. Simple models using sheet metaloperations
9. Study of deep drawing and extrusionoperations
10. Study of Basic powder compaction andsintering
11. Study of TIG/MIGWelding
12. Study of Resistance SpotWelding
13. Study of Brazing andsoldering
14. Study of Plastic MouldingProcess.

II Year - I Semester		L	T	P	C
		0	0	4	2
DRAFTING AND MODELING LAB					

1. **DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files.
2. **SURFACE MODELING -** Generation of various Surfaces using surface modeling.

A) DRAFTING: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files.

B) SURFACE MODELING - Generation of various Surfaces using surface modeling.

C) The following contents to be done by any 3D software package:

(i) PART MODELING: Generation of various 3D models through Pad, revolve, shell, sweep, parent child relation, Boolean operations and various standard translators.

(ii) Assembly drawings: (Any four of the following using solid model software) Generation of various Parts/assemblies: like Screw Jack, Oldham’s Coupling, Foot step bearing, Couplings, knuckle and cotter joints, Crankshaft, Connecting Rod, Piston and Cylinder.

II Year - I Semester		L	T	P	C
		2	0	0	0
ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE					

Course Objectives:

To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system

- The course aim of the importing basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act2003
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection
- To know the student traditional knowledge in different sector

Course Outcomes:

After completion of the course, students will be able to:

- Understand the concept of Traditional knowledge and itsimportance
- Know the need and importance of protecting traditionalknowledge
- Know the various enactments related to the protection of traditionalknowledge
- Understand the concepts of Intellectual property to protect the traditionalknowledge

UNIT I

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

UNIT II

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT III

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.Geographical indications act 2003.

UNIT IV

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT V

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

REFERENCE BOOKS:

1. Traditional Knowledge System in India, by Amit Jha,2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, PratibhaPrakashan2012.
3. Traditional Knowledge System in India by Amit Jha Atlantic publishers,2002
4. "Knowledge Traditions and Practices of India" Kapil Kapoor, MichelDanino

e-Resources:

1) https://www.youtube.com/watch?v=LZP1StpYEPM
2) http://nptel.ac.in/courses/121106003/

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
KAKINADA - 533 003, Andhra Pradesh, India

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DEPARTMENT OF MECHANICAL ENGINEERING

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC-5	Vector Calculus, Fourier Transforms and PDE(M-III)	3	0	0	3
2	PCC-1	Mechanics of Solids	3	0	0	3
3	PCC-2	Fluid Mechanics & Hydraulic Machines	3	0	0	3
4	PCC-3	Production Technology	3	0	0	3
5	PCC-4	Kinematics of Machinery	3	0	0	3
6	PCC-L1	Computer Aided Engineering Drawing Practice	0	0	3	1.5
7	PCC-L2	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
8	PCC-L3	Production Technology Lab	0	0	3	1.5
9	SOC-1	Drafting and Modeling Lab	0	0	4	2
10	MC-3	Essence of Indian Traditional Knowledge	2	0	0	0
		Total Credits				**21.5**

II YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	ESC-6	Material Science & Metallurgy	3	0	0	3
2	BSC-6	Complex Variables and Statistical Methods	3	0	0	3
3	PCC-5	Dynamics of Machinery	3	0	0	3
4	PCC-6	Thermal Engineering-I	3	0	0	3
5	HSC-2	Industrial Engineering and Management	3	0	0	3
6	ESC-L4	Mechanics of Solids and Metallurgy Lab	0	0	3	1.5
7	PCC-L6	Machine Drawing Practice	0	0	3	1.5
8	PCC-L7	Theory of Machines Lab	0	0	3	1.5
9	SOC-2	Python Programming Lab	1	0	2	2
		Total Credits				**21.5**
Honors/Minor courses			**4**	**0**	**0**	**4**

* At the end of II Year II Semester, students must complete summer internship spanning between 1 to 2 months (Minimum of 6 weeks), @ Industries/ Higher Learning Institutions/ APSSDC.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India
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

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

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

II Year - II Semester		L	T	P	C
		3	0	0	3
MATERIALS SCIENCE & METALLURGY					

Course Objective: To understand the basic fundamentals of Material science and Physical metallurgy. The basic concepts to be taught will help for the improvement, proper selection and effective utilization of materials which is essential to satisfy the ever increasing demands of the society.

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

UNIT –II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheriodal graphite cast iron, Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.
Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT – III

Heat treatment of 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.

UNIT – IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Sintering Secondary operations-Sizing, coining, machining -Factors determining the use of powder metallurgy-Application of this process.

UNIT – V

Ceramic and composite materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, various methods of component manufacture of composites, particle – reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal – matrix composites and C – C composites. Nano-materials – definition, properties and application

TEXT BOOKS:

1. Introduction to Physical Metallurgy - Sidney H. Avener -McGrawHill
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:

CO1: Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.

CO2: Study the behavior of ferrous and non ferrous metals and alloys and their application in different domains

CO3: Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.

CO4: Grasp the methods of making of metal powders and applications of powder metallurgy

CO5: Comprehend the properties and applications of ceramic, composites and other advanced methods.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
COMPLEX VARIABLES AND STATISTICAL METHODS					

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

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

- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- find the differentiation and integration of complex functions used in engineering problems (L5)
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)
- apply discrete and continuous probability distributions (L3)
- design the components of a classical hypothesis test (L6)
- infer the statistical inferential methods based on small and large sampling tests (L4)

UNIT – I: Functions of a complex variable and Complex integration: (10 hrs)
Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates –Harmonicand conjugate harmonic functions – Milne – Thompson method.

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II: Series expansions and Residue Theorem: (10 hrs)
Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated – Essential –Pole of order m– Residues – Residue theorem (without proof) – Evaluation of real integral of the types $\int_{-\infty}^{\infty} f(x)dx$ and $\int_{c}^{c+2\pi} f(\cos\theta, \sin\theta)d\theta$.

UNIT – III: Probability and Distributions: (10 hrs)
Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: (8 hrs)
Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions – Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

UNIT – V: Tests of Hypothesis: (10 hrs)
Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples) – Tests on proportions.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **Miller and Freund's,** Probability and Statistics for Engineers,7/e, Pearson, 2008.

Reference Books:

1. **J. W. Brown and R. V. Churchill**, Complex Variables and Applications, 9th edition, Mc-Graw Hill, 2013.
2. **S.C. Gupta and V.K. Kapoor**, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
3. **Jay l. Devore,** Probability and Statistics for Engineering and the Sciences, 8thEdition,Cengage.
4. **ShronL.Myers, Keying Ye, Ronald E Walpole,** Probability and Statistics Engineers and the Scientists, 8th Edition, Pearson 2007.
5. **Sheldon, M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4thEdition, Academic Foundation, 2011

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
DYNAMICS OF MACHINERY					

Course Objectives:

1. To analyze the forces in clutches, brakes and dynamometers involving friction.
2. Understand the effect gyroscopic couple in motor cycles, aeroplanes and ships.
3. To understand the static and dynamic force analysis of four bar and slider crank mechanisms.
4. To study the turning moment diagrams of reciprocating engines and to learn design procedure of a flywheel
5. To learn analytical and graphical methods for calculating balancing of rotary and reciprocating masses
6. Understanding of vibrations and its significance on engineering design.

UNIT – I

FRICTION: Inclined plane, friction of screw and nuts, pivot and collar, uniform pressure, uniform wear, friction circle and friction axis: lubricated surfaces, boundary friction, film lubrication.

CLUTCHES: Friction clutches- single disc or plate clutch, multiple disc clutch, cone clutch, centrifugal clutch.

BRAKES AND DYNAMOMETERS: Simple block brakes, internal expanding brake, band brake of vehicle. General description and operation of dynamometers: Prony, Rope brake, Epicyclic, Bevis Gibson and belt transmission,

UNIT – II

STATIC AND DYNAMIC FORCE ANALYSIS: Dynamic force analysis of four bar mechanism and slider crank mechanism**,** inertia torque, angular velocity and acceleration of connecting rod, crank effort **TURNING MOMENT DIAGRAMS:** Turning moment diagrams

– fluctuation of energy – fly wheels and their design.

UNIT-III

PRECESSION: Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships.

GOVERNERS: Watt, porter and proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronism and hunting.

UNIT – IV

BALANCING: Balancing of rotating masses single and multiple – single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses. analytical and graphical methods, unbalanced forces and couples – examination of "V" multi cylinder in line and radial engines for primary and secondary balancing, locomotive balancing, hammer blow, swaying couple, variation of tractive effort.

UNIT – V

VIBRATIONS: Free Vibration of spring mass system –Natural frequency-types of damping – damped free vibration, Simple problems on forced damped vibration, vibration isolation and transmissibility transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly's methods, Raleigh's method, whirling of shafts, critical speeds, torsional vibrations, two and three rotor systems.

Text Books:

1. Theory of Machines -S.S Rattan - Mc. GrawHill
2. Theory of Mechanisms and Machines -Dr.JagadishLal - Metropolitan Pvt.Ltd.

References:

1. Mechanism and machine theory - JS Rao & RV Dukkipati - New AgePublishers.
2. Theory of Machines - Shigley – McGrawHillPublishers
3. Theory of Machines - Thomas Bevan - PearsonPublishers

Course outcomes:

1. To compute the frictional losses and transmission in clutches, brakes anddynamometers
2. To determine the effect of gyroscopic couple in motor vehicles, ships andaeroplanes
3. To analyze the forces in four bar and slider crank mechanisms and design aflywheel
4. To determine the rotary unbalanced mass in reciprocatingequipment
5. To determine the unbalanced forces and couples in reciprocating and radialengines
6. To determine the natural frequencies of discrete systems undergoing longitudinal, torsional and transverse vibrations.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
THERMAL ENGINEERING - I					

Course Objectives:

1. To make the student learn and understand the reasons and affects of various losses that occur in the actual engine operation.
2. To familiarize the student with the various engine systems along with their function and necessity.
3. To learn about normal combustion phenomenon and knocking in S.I. and C.I. Engines and to find the several engine operating parameters that affect the smooth engine operation.
4. To make the student learn to perform testing on S.I and C.I Engines for the calculations of performance and emission parameters.

UNIT – I

Air standard Cycles: otto, diesel and dual cycles, its comparison, Brayton cycle

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

UNIT – II

I. C. ENGINES : Classification - Working principles, Valve and Port Timing Diagrams, - Engine systems – Fuel, Carburettor, Fuel Injection System, Ignition, Cooling and Lubrication, principle of wankle engine, principles of supercharging and turbocharging.

UNIT – III

Combustion in S.I. Engines : Normal Combustion and abnormal combustion – Importance of flame speed and effect of engine variables – Types of Abnormal combustion, pre-ignition and knocking (explanation of) – Fuel requirements and fuel rating, anti knock additives – combustion chamber – requirements, types.

Combustion in C.I. Engines : Four stages of combustion – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence – open and divided combustion chambers and nozzles used – fuel requirements and fuel rating.

UNIT – IV

Measurement, Testing and Performance: Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart.

UNIT –V

GAS TURBINES: Simple gas turbine plant – ideal cycle, essential components – parameters of performance – actual cycle – regeneration, inter cooling and reheating –closed cycle type gas turbines.

JET PROPULSION: Principle of operation –classification of jet propulsive engines – working principles with schematic diagrams and representation on t-s diagram - thrust, thrust power and propulsion efficiency – turbo jet engines – needs and demands met by turbo jet – schematic diagram, thermodynamic cycle, performance evaluation (Definitions and Simple Problems).

ROCKETS: Application – working principle – classification – propellant type – thrust, propulsive efficiency – specific impulse – solid and liquid propellant rocket engines
(only Theoretical concepts).

<u>Text Books:</u>

1. I.C. Engines - V. Ganesan- Tata McGraw Hill Publishers
2. Gas Turbines – V.Ganesan – Tata McGraw HillPublishers

<u>References:</u>

1. Thermal Engineering - Mahesh Rathore- McGraw Hillpublishers
2. I.C.Engines–AppliedThermosciences–C.R.Ferguson&A.T.Kirkpatrick-2ndEdition-WileyPubl
3. I.C. Engines - J.B.Heywood/McGrawHIll.
4. Heat engines, Vasandani& Kumar – Thermalpublications
5. Gas Turbine Theory – HIH Saravanamuttoo, Cohen, Rogers –PearsonPublishers

Course Outcomes: Student must able to,

CO1: Derive the actual cycle from fuel-air cycle and air- standard cycle for all practical applications. CO2: Explain working principle and various components of IC engine
CO3: Explain combustion phenomenon of CI and SI engines and their impact on engine variables. CO4: Analyze the performance of an IC engine based on the performance parameters.
CO5: Explain the cycles and systems of a gas turbine and determine the efficiency of gas turbine. CO6: Explain the applications and working principle of rockets and jet propulsion.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

II Year – II Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL ENGINEERING AND MANAGEMENT					

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

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

UNIT – III
WORK STUDY: Importance, types of production, applications, workstudy, 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 – IV
STATISTICAL QUALITY CONTROL: Quality control, Queing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – $\overline{X}$ and R – charts $\overline{X}$ and S charts and their applications, numerical examples.
TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation,

applications, ISO quality systems. six sigma – definition, basic concepts

UNIT – V
RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.
VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chainmanagement.

TEXT BOOKS:

1. Industrial Engineering and management / O.P Khanna/KhannaPublishers.
2. Industrial Engineering and Production Management/MartandTelsang/S.Chand& CompanyLtd. New Delhi

Reference Books:

1. Industrial Management / Bhattacharya DK/Vikaspublishers
2. Operations Management / J.G Monks/McGrawHillPublishers.
3. Industrial Engineering and Management Science/T.R. Banga, S.C.Sharma, N. K. Agarwal / Khanna Publishers
4. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.
5. Statistical Quality Control /Gupta/KhannaPublishers
6. Industrial Engineering and Management /NVS Raju/Cengage Publishers

Course outcomes:

Upon successful completion of this course you should be able to:

1. Design and conduct experiments, analyse, interpret data and synthesize validconclusions
2. Design a system, component, or process, and synthesize solutions to achieve desiredneeds
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
4. Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management

II Year - II Semester		L	T	P	C
		0	0	3	1.5
MECHANICS OF SOLIDS & METALLURGY LAB					

Course Objective: To impart practical exposure on the microstructures of various materials and their hardness evaluation. Also to impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

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

(A) MECHANICS OF SOLIDSLAB:

1. Direct tensiontest
2. Bending teston
   a) Simple supported
   b) Cantileverbeam
3. Torsiontest
4. Hardnesstest
   a) Brinells hardnesstest
   b) Rockwell hardnesstest
5. Test onsprings
6. Compression test oncube
7. Impacttest
8. Punch shear test

(B) METALLURGYLAB:

1. Preparation and study of the Microstructure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Microstructure of Mild steel, Medium carbon steels, High carbon steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrousalloys.
5. Study of the Micro structures of Heat treated steels.
6. Hardeneability of steels by Jominy End QuenchTest.
7. To find out the hardness of various treated and untreated steels.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

II Year - II Semester		L	T	P	C
		0	0	3	1.5
MACHINE DRAWING PRACTICE					

Course Objective: *The student will acquire knowledge in national and International standards while drawing machine components students will also familiarize in drawing assembly, orthographic and sectional views of various machine components.*

Machine Drawing Conventions:

Need for drawing conventions – introduction to IS conventions-Standardization-Interchangeability-Selective assembly-Tolerance

a) Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.

b) Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned.

c) Methodsofdimensioning,generalrulesforsizesandplacementofdimensionsforholes, centers, curved tapered features and surface finish indication

d) Title boxes, their size, location and details - common abbreviations & their liberal usage

e) Types of Drawings – working drawings for machine parts.

PART-A

I. Drawing of Machine Elements and simple parts

Objective: To provide basic understanding and drawing practice of various joint, simplemechanical parts

Selection of Views, additional views for the following machine elements and parts with every drawing proportions.

a) Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, setscrews.
b) Keys, cotter joints, knuckle joint, Hook'sjoint
c) Riveted joints for plates
d) Shaft couplings.
e) Journal, pivot and collar and foot step bearings.

PART-B

II. Assembly Drawings:

Objective: The student will be able to draw the assembly from the individualpart drawing. Drawings of assembled views for the part drawings of the following using conventions and easy drawingproportions.

a) Engine parts –Gear pump, Fuel pump, petrol Engine connecting rod, piston, stuffingboxand eccentric assembly.
b) Other machine parts - Screws jack, Machine swivel vice, Plummer block, Tailstock and Tool post.

III. Manufacturing Drawing

Introduction of Limits and fits, fundamental deviations for Hole based and Shaft based systems, alpha numeric designation of limits & fits. Types of Fits. Form and positional tolerances.

Conventional practices of indicating limits and fits, geometrical form and position tolerances, surface finish and surface treatments requirements. Study of Examples involving selection of fits and calculation of limits. Suggestion of suitable fits for mating parts.

Representation of limits fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

TEXT BOOKS:

1. Machine Drawing – N.Siddeswar, K.Kannaiah&V.V.S.Sastry -TMH
2. Machine Drawing –K.L.Narayana, P.Kannaiah&K. Venkata Reddy / New Age/Publishers
3. Production Drawing- K.L.Narayana, P.Kannaiah&K. Venkata Reddy / New Age/Publishers

REFERENCES:

1. Machine Drawing –P.S.Gill,
2. Machine Drawing –Luzzader
3. Machine Drawing –Rajput
4. Machine Drawing – N.D. Junnarkar,Pearson
5. Machine Drawing – Ajeeth Singh, McGrawHill
6. Machine Drawing – KC John,PHI
7. Machine Drawing – B Battacharya,Oxford
8. Machine Drawing – Gowtham and Gowtham,Pearson
9. Machine Drawing- Dhawan R K-S.chand&Company

Course Outcome:

CO1. Draw and represent standard dimensions of different mechanical fasteners and joints and Couplings.
CO2. Draw different types of bearings showing different components.
CO3. Assemble components of a machine part and draw the sectional assembly drawing showing the dimensions of all the components of the assembly as per bill of materials
CO4. Select and represent fits and geometrical form of different mating parts in assembly drawings.
CO5: To prepare manufacturing drawings indicating fits, tolerances, surface finish and surface treatment requirements.

II Year - II Semester		L	T	P	C
		0	0	3	1.5
THEORY OF MACHINES LAB					

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

II Year - II Semester		L	T	P	C
		1	0	2	2
PYTHON PROGRAMMING LAB					

Course Objective: To understand the PYTHON environment and make numerical computations and analysis.

Course Outcomes:

At the end of the course, student will be able to

CO1 Solve the different methods for linear, non-linear and differential equations

CO2 Learn the PYTHON Programming language

CO3 Familiar with the strings and matrices in PYTHON

CO4 Write the Program scripts and functions in PYTHON to solve the methods

CONTENTS

Write Programs in PYTHON Programming for the following:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF MECHANICAL ENGINEERING

1. To find the roots of non-linear equation using Bisection method
2. To find the roots of non-linear equation using Newton Raphson's method.
3. Curve fitting by least – square approximations
4. To solve the system of linear equations using Gauss - elimination method
5. To solve the system of linear equations using Gauss - Siedal method
6. To solve the system of linear equations using Gauss - Jordan method
7. To integrate numerically using Trapezoidal rule
8. To integrate numerically using Simpsons rule
9. To find the largest eigen value of a matrix by Power – method
10. To find numerical solution of ordinary differential equations by Euler's method
11. To find numerical solution of ordinary differential equations by Runge-Kutta method
12. To find numerical solution of ordinary differential equations by Milne's method
13. To find the numerical solution of Laplace equation
14. To find the numerical solution of Wave equation
15. To find the solution of a tri-diagonal matrix using Thomas algorithm
16. To fit a straight using least square technique

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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 4^{th} 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, 3^{rd} 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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

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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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.

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:

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.

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

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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

MINOR		L	T	P	C
		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.

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

MINOR		L	T	P	C

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.

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

	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

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

Metaverse – Basic Concepts, AR/VR, Social Metaverse, Industrial 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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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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.

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.

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.

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

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.

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

CO 1: Understand 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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

Course Outcomes: At the end of the course, student 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.

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

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
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.

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 BOOK:

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					

Course Objective:

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.

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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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

UNIT – 5

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
		4	0	0	4
ELECTRIC AND HYBRID VEHICLES					

Course objectives: To

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

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

	L	T	P	C
	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.

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.

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

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:

1) To demonstrate basic concepts of motion controllers, robot 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

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.

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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HONORS		**L**	**T**	**P**	**C**
		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.

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.

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COURSE STRUCTURE

For UG – R20

B. TECH - MECHANICAL ENGINEERING

(Applicable for batches admitted from 2020-2021)

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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.

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).

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 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

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF MECHANICAL ENGINEERING

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**.**

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

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.

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.

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF MECHANICAL ENGINEERING

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,

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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DEPARTMENT OF MECHANICAL ENGINEERING

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECTS FOR B.Tech (MINOR) in MECHANICAL ENGINEERING

<table>
<tr><td rowspan="2">MINOR</td><td rowspan="2"></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td colspan="6">BASIC THERMODYNAMICS</td></tr>
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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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

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:

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.

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

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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

MINOR		L	T	P	C
		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.

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

MINOR		L	T	P	C

	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.

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

	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

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

Metaverse – Basic Concepts, AR-VR, Social Metaverse, Industrial 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

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.

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.

MINOR		L	T	P	C
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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

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF MECHANICAL ENGINEERING

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.

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

CO 1: Understand 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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

Course Outcomes: At the end of the course, student 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.

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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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

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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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.

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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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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
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.

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 BOOK:
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 modeling: 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					

Course Objective:

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.

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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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

UNIT – 5

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
		4	0	0	4
ELECTRIC AND HYBRID VEHICLES					

Course objectives: To

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

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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	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.

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**

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:

1) To demonstrate basic concepts of motion controllers, robot 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

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.

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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HONORS		L	T	P	C
		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.

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.

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

KAKINADA - 533 003, Andhra Pradesh, India

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DEPARTMENT OF MECHANICAL ENGINEERING

III B.TECH II SEMESTER

S.No	Code	Course Title	Hours			Credits
			L	T	P	
1	PCC-10	Heat Transfer	3	0	0	3
2	PCC-11	Design of Machine Members-II	3	0	0	3
3	PCC-12	Introduction to Artificial Intelligence and Machine Learning	3	0	0	3
4	PE-2	1.Automobile Engineering 2.Smart Manufacturing 3.Advanced Mechanics of Solids 4.Statistical Quality Control 5.Industrial Hydraulics and Pneumatics 6.MOOCs (NPTEL/ Swayam) Course (12 Week duration)	3	0	0	3
5	OE-2	1.Industrial Robotics 2.Essentials of Mechanical Engineering 3.Advanced Materials 4.Introduction to Automobile Engineering	3	0	0	3
6	PCC-L8	Heat Transfer Lab	0	0	3	1.5
7	PCC-L9	CAE&CAM Lab	0	0	3	1.5
8	PCC-L10	Measurements & Metrology Lab	0	0	3	1.5
9	SOC-4	Artificial Intelligence and Machine Learning Lab	0	0	4	2
10	MC - 5	Research Methodology and IPR	2	0	0	0
					Total credits	**21.5**
		Honors/Minor courses	**4**	0	0	**4**

* At the end of III Year II Semester, students shall complete summer internship spanning between 1 to 2 months at Industries/ Higher Learning Institutions/ APSSDC.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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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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DEPARTMENT OF MECHANICAL ENGINEERING

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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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3

HEAT TRANSFER
(Heat transfer data book is allowed)

Course objectives:
1) To gain knowledge about mechanism and modes of heat transfer.
2) To understand the concepts of conduction and convective heat transfer.
3) To gain knowledge about the forced and free convection.
4) To understand the concepts of heat transfer with phase change and condensation along with heat exchangers.
5) To gain knowledge about radiation mode of heat transfer.

UNIT– I:
Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.
Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions
One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation. Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature.

UNIT– II:
One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.
Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations

UNIT– III:
Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.
Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.
Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

UNIT– IV:
Heat Transfer with Phase Change: Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling
Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.
Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT– V:
Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS:
1) Heat Transfer by HOLMAN, Tata McGraw-Hill.
2) Heat Transfer by P.K.Nag, TMH.

REFERENCE BOOKS:
1) Fundamentals of Heat Transfer by Incropera& Dewitt, John Wiley.
2) Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, NewAge.
3) Heat& Mass Transfer by Amit Pal – Pearson Publishers.
4) Heat Transfer by Ghoshadastidar, Oxford University press.
5) Heat Transfer by a Practical Approach, YunusCengel, Boles, TMH.
6) Engineering Heat and Mass Transfer by Sarit K. Das, DhanpatRai Pub.

Note: Heat and Mass transfer Data Book by C P Kothandaraman and Subrahmanyan is used to design and analyze various thermal processes and thermal equipment.

Course outcomes: At the end of the course, student will be able to
CO1: Apply knowledge about mechanism and modes of heat transfer.
CO2: Understand the concepts of conduction and convective heat transfer.
CO3: Learn about forced and free convection.
CO4: Analyze the concepts of heat transfer with phase change and condensation along with heat exchangers.
CO5: Interpret the knowledge about radiation mode of heat transfer.

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

Course objectives:
1) To gain knowledge about the design of bearings.
2) To understand the concepts in designing various engine parts.
3) To gain knowledge to design curved beams and power screws.
4) To understand power transmission systems and to design pulleys and gear drives.
5) To understand the concepts in designing various machine tool elements.

UNIT– I:
BEARINGS: Classification of bearings- applications, types of journal bearings – lubrication – bearing modulus – full and partial bearings – clearance ratio – heat dissipation of bearings, bearing materials – journal bearing design – ball and roller bearings – static loading of ball & roller bearings, bearing life.

UNIT– II:
ENGINE PARTS: Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – cranks and crank shafts, strength and proportions of over hung and center cranks – crank pins, crank shafts.
Pistons, forces acting on piston – construction design and proportions of piston, cylinder, cylinder liners,

UNIT– III:
DESIGN OF CURVED BEAMS: introduction, stresses in curved beams, expression for radius of neutral axis for rectangular, circular, trapezoidal and t-section, design of crane hooks, c –clamps**.**
DESIGN OF POWER SCREWS: Design of screw, square ACME, buttress screws, design of nut, compound screw, differential screw, ball screw- possible failures.

UNIT– IV:
POWER TRANSMISSIONS SYSTEMS, PULLEYS: Transmission of power by belt and rope drives, transmission efficiencies, belts – flat and V types – ropes - pulleys for belt and rope drives, materials, chain drives
SPUR & HELICAL GEAR DRIVES: Spur gears- helical gears – load concentration factor – dynamic load factor, surface compressive strength – bending strength – design analysis of spur gears – estimation of centre distance, module and face width, check for plastic deformation, check for dynamic and wear considerations.

UNIT– V:
MACHINE TOOL ELEMENTS: Levers and brackets: design of levers – hand levers-foot lever – cranked lever – lever of a lever loaded safety valve- rocker arm straight – angular- design of a crank pin – brackets- hangers- wall boxes.
Wire Ropes: Construction, Designation, Stresses in wire ropes, rope sheaves and drums.

Note: Design data book is permitted for examination

TEXT BOOKS:
1. Machine Design/ V. Bhandari/TMH Publishers
2. Machine Design/ NC Pandya & CS Shaw/ Charotar publishers

REFERENCES:
1. Machine Design: An integrated Approach / R.L. Norton / Pearson Education
2. Mech. Engg. Design / JE Shigley/Tata McGraw Hill education
3. Design of machine elements- spots/Pearson Publications
4. Machine Design-Norton/Pearson Publications.

Course Outcomes: At the end of the course, student will be able to
CO1: Apply knowledge about the design of bearings.
CO2: Explain the concepts in designing various engine parts.
CO3: Utilize the knowledge to design curved beams and power screws.
CO4: Justify power transmission systems and to design pulleys and gear drives.
CO5: Apply the concepts in designing various machine tool elements.

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III Year - II Semester		L	T	P	C
		3	0	0	3
INTRODUCTION TO ARTIFICIAL INTELLIGENCE & MACHINE LEARNING					

Course objectives:
1) To understand the basic concepts of artificial intelligence, neural networks and genetic algorithms.
2) To understand the principles of knowledge representation and reasoning.
3) To gain knowledge about bayesian and computational learning and machine learning.
4) To explore various machine learning techniques.
5) To understand the machine learning analytics and deep learning techniques.

UNIT– I:
Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and environments; Good Behavior-The concept of rationality, the nature of environments, structure of agents.
Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptrons, multilayer networks and back propagation algorithms, Genetic algorithms.

UNIT– II:
Knowledge–Representation and Reasoning: Logical Agents: Knowledge based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification and lifting

UNIT– III:
Bayesian and Computational Learning: Bayes theorem , concept learning, maximum likelihood, minimum description length principle, Gibbs Algorithm, Naïve Bayes Classifier, Instance Based Learning- K-Nearest neighbour learning
Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real world, classification; differences between supervised and unsupervised learning paradigms.

UNIT– IV:
Basic Methods in Supervised Learning: Distance-based methods, Nearest-Neighbors, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.
Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and kernel.

UNIT– V:
Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods (Boosting, Bagging, and Random Forests).
Modeling Sequence/Time-Series Data and Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

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.

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) T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, 1/e, Springer, 2001.
4) Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.
5) M. Narasimha Murty, Introduction to Pattern Recognition and Machine Learning, World Scientific Publishing Company, 2015.

Course outcomes: At the end of the course, student will be able to
CO1: Discuss basic concepts of artificial intelligence, neural networks and genetic algorithms.
CO2: Apply the principles of knowledge representation and reasoning.
CO3: Learn about bayesian and computational learning and machine learning.
CO4: Utilize various machine learning techniques.
CO5: Apply the machine learning analytics and deep learning techniques.

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III Year - II Semester		L	T	P	C
		3	0	0	3
AUTOMOBILE ENGINEERING (PE-2)					

Course objectives:
1) To understand various components of four wheeler automobile.
2) To gain knowledge of different parts of transmission system.
3) To understand the concepts of steering and suspension systems.
4) To gain knowledge about the braking system and electrical system used in automobiles.
5) To understand the concepts about engine specifications and service, safety and electronic system used in automobiles.

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 automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation – engine service, reboring, decarbonisation, Nitriding of crank shaft.

UNIT– II:
TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate 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 and their making.

UNIT– III:
STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toein, centre point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.
SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

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

UNIT– V:
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.
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.
AUTOMOBILE ELECTRONIC SYSTEMS:
Concept of CPU and computer memory used in automobiles, sensors- Pressure sensor, Throttle position sensor, fuel flow sensor, thermistor sensor, oxygen sensor, speed sensors, knock detecting sensor, actuators solenoids and stepper motor, Electronic dash board instruments - Onboard diagnosis system, security and warning system.

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: At the end of the course, student will be able to
CO1: Discuss various components of four wheeler automobile.
CO2: Apply the knowledge of different parts of transmission system.
CO3: Judge about steering and suspension systems.
CO4: Justify the braking system and electrical system used in automobiles.
CO5: Analyze the concepts about engine specifications and service, safety and electronic system used in automobiles.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
SMART MANUFACTURING (PE-2)					

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:
Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial 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.

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III Year - II Semester		L	T	P	C
		3	0	0	3
ADVANCED MECHANICS OF SOLIDS (PE-2)					

Course objectives:
1) To understand the principles of failure criteria.
2) To determine the stresses and deflection in unsymmetrical bending of beams.
3) To gain knowledge about curved beam theory.
4) To understand concept about torsion.
5) To analyze the contact stresses.

UNIT– I:
FAILURE CRITERIA: Modes of failure, Excessive deflections, Yield initiation, fracture, Progressive fracture, High Cycle fatigue for number of cycles $N > 10^6$, buckling. Concept of Creep. Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT– II:
UNSYMMETRICAL BENDING: Bending stresses in Beams subjected to Non-symmetrical bending; Deflection of straight beams due to non-symmetrical bending.

UNIT– III:
CURVED BEAM THEORY: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT– IV:
TORSION: Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hollow thin wall torsion members, Multiply connected Cross Section.

UNIT– V:
CONTACT STRESSES: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

TEXT BOOKS:

1) Advanced Mechanics of materials by Boresi& Sidebottom-Wiley International.
2) Theory of elasticity by Timoshenko S.P. and Goodlier J.N. McGraw-Hill Publishers 3rd Edition.
3) Advanced Mechanics of Solids, L.S Srinath.

REFERENCE BOOKS:

1. Advanced strength of materials by Den Hortog J.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia.
4. Strength of materials by Sadhu Singh.

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

CO1: Explain the principles of failure criteria.
CO2: Determine the stresses and deflection in unsymmetrical bending of beams.
CO3: Apply the knowledge about curved beam theory.
CO4: Interpret the concept of torsion.
CO5: Analyze the contact stresses.

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III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
STATISTICAL QUALITY CONTROL (PE-2)					

Course objectives:
1) To understand the concepts of quality systems and quality engineering in design and processes.
2) To acquire knowledge about the statistical process control charts and sampling techniques.
3) To analyze the loss function and quality function deployment.
4) To explore the models of reliability engineering.
5) To gain knowledge about the concepts of complex system and reliability engineering techniques.

UNIT– I:
Quality value and engineering – quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design, quality costs – quality improvement.

UNIT– II:
Statistical process control $\overline{X}$, R, p, c charts, other types of control charts, process capability, process capability analysis, process capability index. (SQC tables can be used in the examination)
Acceptance sampling by variables and attributes, design of sampling plans, single, double, sequential and continuous sampling plans, design of various sampling plans.

UNIT– III:
Loss function, tolerance design – N type, L type, S type; determination of tolerance for these types. Online quality control – variable characteristics, attribute characteristics, parameter design. Quality function deployment – house of quality, QFD matrix, total quality management concepts. Quality information systems, quality circles, introduction to ISO 9000 standards.

UNIT– IV:
Reliability – Evaluation of design by tests - Hazard Models, Linear, Releigh, Weibull. Failure Data Analysis, reliability prediction based on Weibull distribution, Reliability improvement.

UNIT– V:
Complex system, reliability, reliability of series, parallel & standby systems & complex systems & reliability prediction and system effectiveness.
Maintainability, availability, economics of reliability engineering, replacement of items, maintenance costing and budgeting, reliability testing.

TEXT BOOKS:
1. Quality Engineering in Production Systems / G Taguchi /McGraw Hill.
2. Reliability Engineering/ E.Bala Guruswamy/Tata McGraw Hill.
3. Statistical Quality Control: A Modern Introduction/ Montgomery/Wiley.

REFERENCES:
1) Jurans Quality planning & Analysis/ Frank.M.Gryna Jr. / McGraw Hill.
2) Taguchi Techniques for Quality Engineering/ Philipposs/ McGraw Hill.
3) Reliability Engineering / LS Srinath / Affiliated East West Pvt. Ltd.
4) Statistical Process Control/ Eugene Grant, Richard Leavenworth / McGraw Hill.
5) Optimization & Variation Reduction in Quality / W.A. Taylor / Tata McGraw Hill.
6) Quality and Performance Excellence/ James R Evans/ Cengage learning

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

CO1: Discuss the concepts of quality systems and quality engineering in design and processes.
CO2: Utilize knowledge about the statistical process control charts and sampling techniques.
CO3: Analyze the loss function and quality function deployment.
CO4: Judge the models of reliability engineering.
CO5: Apply knowledge about the concepts of complex system and reliability engineering techniques.

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III Year - II Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL HYDRAULICS AND PNEUMATICS (PE-2)					

Course objectives:
1) To understand the principles and laws of fluid power.
2) To explore the hydraulic and pneumatic elements and their accessories.
3) To analyze and design the hydraulic and pneumatic circuits.
4) To understand and apply the principles of hydraulic and pneumatic devices.
5) To gain knowledge about installation, maintenance and trouble shooting of hydraulic and pneumatic systems.

UNIT– I:
Fluid Power: Power transmission modes, hydraulic systems, pneumatic systems, laws governing fluid flow: Pascal's law, continuity equation, Bernoulli's theorem, Boyle's, Charles', Gay-Lussec' laws, flow through pipes - types, pressure drop in pipes, Working fluids used in hydraulic and pneumatic systems- types, ISO/BIS standards and designations, properties.

UNIT– II:
Hydraulic and Pneumatic Elements: Hydraulic pipes-Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria, pumping theory, Hydraulic Pumps - types, construction, working principle, applications, selection criteria and comparison, hydraulic Actuators, Control valves, Accessories - their types, construction and working, pneumatic Pipes - materials, designations, standards, properties and piping layout, air compressors, Air receivers, air dryers, Air Filters, Regulators, Lubricators (FRL unit): their types, construction, working, specifications and selection criteria of following air preparation and conditioning elements, pneumatic Actuators and Control valves - types, construction, working, materials and specifications

UNIT– III:
Hydraulic and Pneumatic Circuits: ISO symbols used in hydraulic and pneumatic circuit, basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram, components, working and applications, basic Pneumatic Circuits – types (such as speed control, two step feed control, automatic cylinder reciprocation, time delay, quick exhaust), circuit diagram, components, working and applications, pneumatic Logic circuit design - classic method, cascade method, step counter method, Karnaugh- Veitch maps and combinational circuit design.

UNIT– IV:
Hydraulic and Pneumatic Devices: Hydraulic and Pneumatic devices – Concept and applications, construction, working principle, major elements, performance variables of: Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, Automotive power steering, Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun.

UNIT– V :
Installation, Maintenance and Trouble-Shooting: Installation of hydraulic and pneumatic system causes and remedies for common troubles arising in hydraulic elements, maintenance of hydraulic systems, causes and remedies for troubles arising in pneumatic elements, maintenance of pneumatic systems.

TEXTBOOKS:

1) Majumdar, S.R. Oil Hydraulic Systems Tata McGraw-Hill Publication, New Delhi,3/e, 2013.
2) Majumdar, S.R. Pneumatic Systems Tata McGraw-Hill Publication, New Delhi,3/e, 2013.

REFERENCES:

1) Srinivasan, R. Hydraulic and Pneumatic Controls Vijay Nicole Imprints Private, New Delhi, Limited, 2/e, 2008.
2) Jagadeesha, T. Fluid Power Generation, Transmission and Control Universities Press (India) Private Limited, New Delhi,1/e, 2014.
3) Jagadeesha, T. Pneumatics Concepts, Design and Applications Universities Press (India) Private Limited, New Delhi,1/e, 2014.
4) Parr, Andrew Hydraulic and Pneumatics, A Technician's and Engineer's Guide, Jaico Publishing House, New Delhi,2/e, 2013.
5) Shanmuga Sundaram, K. Hydraulic and Pneumatics Controls - Understanding Made Easy S. Chand Company Ltd., New Delhi, 1/e, 2006.

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

CO1: Discuss the principles and laws of fluid power.
CO2: Judge the hydraulic and pneumatic elements and their accessories.
CO3: Analyze and design the hydraulic and pneumatic circuits.
CO4: Apply the principles of hydraulic and pneumatic devices.
CO5: Analyze knowledge about installation, maintenance and trouble shooting of hydraulic and pneumatic systems.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
MOOCs (NPTEL/SWAYAM) Course (PE-2)					

Students shall complete a course relevant to Mechanical Engineering through NPTEL or SWAYAM.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
INDUSTRIAL ROBOTICS (OE-2)					

Course objectives:
1) To understand the basic concepts and components of industrial robotics and automation.
2) To acquire knowledge about robot actuators and feedback components.
3) To analyze the motion of robot and manipulator kinematics.
4) To know the general considerations of path description and generation.
5) To gain knowledge about the image processing, machine vision 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, functions, 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.

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 /Richard D. Klafter, PrenticeHal.l
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

CO1: Explain the basic concepts and components of industrial robotics and automation.
CO2: Judge the knowledge about robot actuators and feedback components.
CO3: Analyze the motion of robot and manipulator kinematics.
CO4: Analyze the general considerations of path description and generation.
CO5: Utilize knowledge about the image processing, machine vision and robotic applications.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
ESSENTIALS OF MECHANICAL ENGINEERING (OE-2)					

Course objectives:
1) To understand the concepts about stresses and strains.
2) To gain knowledge about the components of transmission systems.
3) To acquire knowledge about project management techniques.
4) To gain knowledge about manufacturing processes and materials.
5) To understand the concepts of boilers, steam power plant, petrol and diesel engines.

UNIT– I:
STRESSES AND STRAINS: Types of stresses and strains, elasticity, plasticity, Hooke's law, stress-strain diagrams, modules of elasticity, Poisson's ratio, linear and volumetric strain, compound bars and temperature stresses.
Types of supports – loads – Shear force and bending moment for cantilever and simply supported beams.

UNIT– II:
TRANSMISSION SYSTEMS: Belts –Ropes and chain: belt and rope drives, velocity ratio, slip, length of belt , open belt and cross belt drives, ratio of friction tensions, power transmitted by belts.
Gears- Nomenclature, classification, Gear Trains- velocity ratio, classification.

UNIT– III:
PROJECT MANAGEMENT: CPM, PERT, JIT, MRP, ERP, Work Study, Time study and sampling.

UNIT– IV:
MANUFACTURING PROCESSES: Introduction to metal casting, forming, welding and machining processes. Working of lathe, shaper, milling machines, CNC machines.
Introduction to materials- metals- ferrous, non-ferrous and non-metals.

UNIT– V:
STEAM BOILERS: Introduction to boilers, working Babcock and Willcox and Cochran boilers.
STEAM POWER PLANT: Plant layout, working of different circuits.
Internal combustion Engines: classification of IC engines, basic engine components and nomenclature, working principle of engines, Four strokes and two stroke petrol and diesel engines, comparison of CI and SI engines, comparison of four stroke and two stroke engines.

TEXT BOOKS:
1) Strength of Materials and Mechanics of Structures, B.C.Punmia, Standard Publications and distributions, 9 th Edition, 1991.
2) Thermal Engineering, Ballaney,P.L., Khanna Publishers, 2003.
3) Elements of Mechanical Engineering, A.R.Asrani, S.M.Bhatt and P.K.Shah, B.S. Pub.

REFERENCE BOOKS:
1) Elements of Mechanical Engineering, M.L.Mathur, F.S.Metha& R.P.Tiwari Jain Brothers Publ., 2009**.**
2) Theory of Machines, S.S. Rattan, Tata McGraw Hill., 2004 & 2009.

Course Outcomes: At the end of the course, student will be able to
CO1: Discuss the concepts about stresses and strains.
CO2: Justify about the components of transmission systems.
CO3: Analyze Problems related to project management techniques.
CO4: Utilize knowledge about manufacturing processes and materials.
CO5: Learn the concepts of boilers, steam power plant, petrol and diesel engines.

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DEPARTMENT OF MECHANICAL ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
ADVANCED MATERIALS (OE-2)					

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-transitiontemperature-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 borncarbide 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.

UNIT– V:
NANO MATERIALS: Introduction-properties at nano scales-advantages & disadvantages applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.

TEXT BOOKS:
1) Nano material /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-
4) Interscience, New York, 1980.
5) 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: Explain the metals and alloys and their utility in different environments.
CO2: Learn about polymers and ceramics and their applications.
CO3: Analyze composite materials along with reinforcements and their applications.
CO4: Apply the basics of shape memory alloys and functionally graded materials.
CO5: Analyze the knowledge about the nanomaterials and their applications.

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III Year - II Semester		L	T	P	C
		3	0	0	3
INTRODUCTION TO AUTOMOBILE ENGINEERING (OE-2)					

Course objectives:
1) To understand various components of four wheeler automobile.
2) To gain knowledge of different parts of transmission system.
3) To understand the concepts of steering and suspension systems.
4) To gain knowledge about the braking system and electrical system used in automobiles.
5) To understand the concepts about engine specifications and service, safety of automobiles.

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 automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems.

UNIT– II:
TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate 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 and their making.

UNIT– III:
STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toein, centre point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.
SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, independent suspension system.

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

UNIT– V:
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.

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: At the end of the course, student will be able to
CO1: Explain various components of a four wheeler automobile.
CO2: Discuss the different parts of transmission system.
CO3: Justify the concepts of steering and suspension systems.
CO4: Utilize the knowledge about the braking system and electrical system used in automobiles.
CO5: Analyze the concepts about engine specifications and service, safety of automobiles.

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III Year - II Semester		L	T	P	C
		0	0	3	1.5
HEAT TRANSFER LAB					

Course objectives:
1) To determine the heat transfer rate and coefficient.
2) To determine the thermal conductivity, efficiency and effectiveness.
3) To determine the emissivity and Stefan-Boltzman constant.
4) To determine critical heat flux and investigate Lambert’s cosine law.
5) To experiment with Virtual labs and analyze conduction, HT coefficient.
6) To experiment with Virtual labs and investigate Lambert’s laws.

PART-A

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin
6. Determination of heat transfer coefficient in natural and forced convection
7. Determination of effectiveness of parallel and counter flow heat exchangers.
8. Determination of emissivity of a given surface.
9. Determination of Stefan-Boltzmann constant.
10. Determination of heat transfer rate in drop and film wise condensation.
11. Determination of critical heat flux.
12. Determination of Thermal conductivity of liquids and gases.
13. Investigation of Lambert’s cosine law.

PART-B

Virtual labs (https://mfts-iitg.vlabs.ac.in/) on
1) Conduction Analysis of a Single Material Slab
2) Conduction Analysis of a Single Material Sphere
3) Conduction Analysis of a Single Material Cylinder
4) Conduction Analysis of a Double Material Slab
5) Conduction Analysis of a Double Material Sphere
6) Conduction Analysis of Double Material Cylinder
7) To determine the overall heat transfer coefficient (U) in the (i) parallel flow heat exchanger and (ii) Counter flow heat exchanger
8) To investigate the Lambert’s distance law.
9) To investigate the Lambert’s direction law (cosine law).

Note: Virtual labs are only for learning purpose, and are not for external examination.

Course outcomes: Students are expected to learn the concepts and to
CO1: Determine the heat transfer rate and coefficient.
CO2: Determine the thermal conductivity, efficiency and effectiveness.
CO3: Determine the emissivity and Stefan-Boltzman constant.
CO4: Determine critical heat flux and investigate Lambert’s cosine law.
CO5: Experiment with Virtual labs and analyse conduction, HT coefficient.
CO6: Experiment with Virtual labs and investigate Lambert’s laws.

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III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
CAE & CAM Lab					

Course objectives:
1) To experiment with trusses and beams to determine stress, deflection, natural frequencies, harmonic analysis, HT analysis and buckling analysis.
2) To demonstrate part programmes using FANUC controller.
3) To generate G-code for automated tool path using CAM software.
4) To demonstrate with rapid prototyping machine and to print simple parts.
5) To experiment with virtual 3D printing simulation using Vlabs.

1. Experiments to determine stresses, deflection, natural frequencies, harmonic analysis, HT analysis and buckling analysis (Any three experiments to be done).
   a) Determination of deflection and stresses in 2D and 3D trusses and beams.
   b) Determination of principal and Von-mises stresses in plane stress, plane strain and axisymmetric components.
   c) Determination of stresses in 3D and shell structures (at least one example in each case)
   d) Estimation of natural frequencies and mode shapes, harmonic response of 2D beam.
   e) Steady state heat transfer analysis of plane and axisymmetric components.
   f) Buckling analysis
2. Study of CNC part programming fundamentals and write part programmes for simple components on CNC lathe and Mill and Study of RP machine. (Any three experiments to be done).
   A. CNC part programming for turned components using FANUC Controller
      (i) Plain turning and facing
      (ii) Step Turning Operation
      (iii) Taper turning
   B. CNC programming for milled components using FANUC Controller
      (i) circular interpolation
      (ii) End milling
      (iii) Pocket milling
3. Automated CNC Tool path and G-Code generation using CAM packages.
4. Study and demonstration of RP machine-creation of simple parts.
5. Virtual 3D Printing Simulation lab using Vlabs.
https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html

Course outcomes: Students are expected to learn the concepts and should be able to

CO1: Experiment with trusses and beams to determine stress, deflection, natural frequencies, harmonic analysis, HT analysis and buckling analysis.
CO2: Create part programmes using FANUC controller.
CO3: Apply G-codes for automated tool path using CAM software.
CO4: Analyze about rapid prototyping machine and to print simple parts.
CO5: Experiment with virtual 3D printing simulation using Vlabs.

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III Year - II Semester		L	T	P	C
		0	0	3	1.5
Measurements & Metrology lab					

Course objectives:
1) To demonstrate the calibration experiments with different gauges, transducers, thermocouple and temperature detector.
2) To demonstrate the calibration experiments with rotameter, seismic apparatus.
3) To demonstrate the calibration experiments with vernier calipers, micrometer, height and dial gauges.
4) To analyze various machine tools for their alignment.
5) To measure angular and taper measurements, straightness, surface roughness.

Note: At least 8 experiments from each lab are to be conducted

MEASUREMENTS LABORATORY
1. Calibration of pressure gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge.
5. Calibration of thermocouple.
6. Calibration of capacitive transducer.
7. Study and calibration of photo and magnetic speed pickups.
8. Calibration of resistance temperature detector.
9. Study and calibration of a rotameter.
10. Study and use of a seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.

METROLOGY LABORATORY
1. Calibration of vernier calipers, micrometer, vernier height gauge and dial gauges.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on drilling machine.
6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

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

1) Demonstrate the calibration experiments with different gauges, transducers, thermocouple and temperature detector.
2) Demonstrate the calibration experiments with rotameter, seismic apparatus.
3) Demonstrate the calibration experiments with vernier calipers, micrometer, height and dial gauges.
4) Analyze various machine tools for their alignment.
5) Measure angular and taper measurements, straightness, surface roughness.

III Year - II Semester		L	T	P	C
		0	0	4	2
Artificial Intelligence and Machine Learning Lab					

Course Objectives: *The students will acquire the knowledge of artificial intelligence and machine learning models along with image classifiers and automatic facial recognition using various software tools.*

1. Data Preprocessing with Weka or Python
2. Building Decision Trees for Soybean classification model using Weka or Python
3. Generating association rules on Weather data using Weka or Python
4. Exploring machine learning models including classification and clustering using scikit-learn or Weka or Python
5. Build Neural Network Classifier using Weka or Python
6. Supervisely - Perform Data Labeling for various images using object recognition
7. Image Classifier using Tensor Flow or OpenCV
8. Automatic Facial recognition using Microsoft Azure or OpenCV

References:

1. Weka Documentation, https://www.cs.waikato.ac.nz/ml/weka/documentation.html
2. Weka Knowledge Flow, https://www.cs.waikato.ac.nz/~eibe/WEKA_Ecosystem.pdf

Course Outcomes: At the end of the course, student will be able to apply the knowledge of artificial intelligence and machine learning models along with image classifiers and automatic facial recognition using various software tools.

III Year - II Semester		L	T	P	C
		2	0	0	0

Research Methodology and IPR

Course objectives:
1) To understand the objectives and characteristics of a research problem.
2) To analyze research related information and to follow research ethics
3) To understand the types of intellectual property rights.
4) To learn about the scope of patent rights.
5) To understand the new developments in IPR.

UNIT - I
Research problem: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT - II
Literature study: Effective literature studies approaches, analysis Plagiarism, Research ethics, Technical writing: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT - III
Nature of Intellectual Property: Patents, Designs, Trade and Copyright.
Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - IV
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT - V
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc, Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:
1) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3) Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

REFERENCES:
1) Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2) Mayall, "Industrial Design", McGraw Hill, 1992.
3) Niebel, "Product Design", McGraw Hill, 1974.
4) Asimov, "Introduction to Design", Prentice Hall, 1962.

5) Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6) T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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

CO1: Understand objectives and characteristics of a research problem
CO2: Analyze research related information and to follow research ethics.
CO3: Understand the types of intellectual property rights.
CO4: Learn about the scope of IPR.
CO5:Understand the new developments in IPR.

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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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 4^{th} 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, 3^{rd} 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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

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:

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.

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

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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

MINOR		L	T	P	C
		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.

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

MINOR		L	T	P	C

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DEPARTMENT OF MECHANICAL ENGINEERING

	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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

	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

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

Metaverse – Basic Concepts, AR/VR, Social Metaverse, Industrial 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

	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.

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.

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.

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF MECHANICAL ENGINEERING

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

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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

CO 1: Understand 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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

Course Outcomes: At the end of the course, student 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.

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

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.

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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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.

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
		4	0	0	4
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.

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 BOOK:
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 / 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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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.

<table>
<tr><td rowspan="2">HONORS</td><td rowspan="2"></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td colspan="6">MATERIALS CHARACTERIZATION TECHNIQUES</td></tr>
</table>

Course Objective:

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.

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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		L	T	P	C
HONORS		**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

UNIT – 5

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
		4	0	0	4
ELECTRIC AND HYBRID VEHICLES					

Course objectives: To

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

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

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.

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:

1) To demonstrate basic concepts of motion controllers, robot 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

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.

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

HONORS		L	T	P	C
		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.

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.

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COURSE STRUCTURE

For UG – R20

B. TECH - MECHANICAL ENGINEERING

(Applicable for batches admitted from 2020-2021)

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IV B.TECH I SEMESTER

S.No	Code	Course Title	Hours			Credits
			L	T	P	
1	PE-3	1. Mechanical Vibrations 2. Operations Research 3. Unconventional Machining Processes 4. Computational Fluid Dynamics 5. Gas Dynamics and Jet Propulsion 6. MOOCs (NPTEL/Swayam) Course (12 Week duration)	3	0	0	3
2	PE-4	1. Automation in Manufacturing 2. Power Plant Engineering 3. Big Data Analytics 4. Production Planning and Control 5.Condition Monitoring 6.MOOCs (NPTEL/Swayam) Course (12 Week duration)	3	0	0	3
3	PE-5	1. Advanced Manufacturing Processes 2. Mechatronics 3. Refrigeration & Air-Conditioning 4. Additive Manufacturing 5. Non Destructive Evaluation 6. MOOCs (NPTEL/Swayam) Course (12 Week duration)	3	0	0	3
4	OE-3	1. Additive Manufacturing 2. Mechatronics 3. Finite Element Methods 4. Introduction to Artificial Intelligence &Machine Learning	3	0	0	3
5	OE-4	1. Optimization Techniques 2. Smart Manufacturing 3. Safety Engineering 4. Operations Management	3	0	0	3
6	HSC-3	Universal Human Values: Understanding Harmony	3	0	0	3
7	SOC-5	Mechatronics Lab	0	0	4	2
Evaluation of Summer Internship which is completed at the end of III B.Tech II Semester						3
		Total credits				**23**
		Honors/Minor courses	4	0	0	**4**

IV B.TECH II SEMESTER

S No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
1	Major Project	PROJ	Project work*	0	4	16	12
			Total credits				**12**

*Students can complete Project work @ Industries/ Higher Learning Institutions/ APSSDC.

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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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IV Year - I Semester		L	T	P	C
		3	0	0	3
MECHANICAL VIBRATIONS (PE-3)					

Course Objectives:

1) To learn basic principles of mathematical modeling of vibrating systems
2) To learn the basic concepts free and forced multi degree freedom systems
3) To learn concepts involved in the torsional vibrations
4) To learn the principles involved in the critical speed of shafts
5) To learn the basic concepts of Laplace transformations response to different inputs

UNIT– I:
Relevance of and need for vibrational 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:
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, modal analysis.

UNIT– III:
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:
Vibration Measuring Instruments and Critical Speeds Of Shafts:Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Critical speed of a light shaft having a single disc without damping and with damping, critical speeds of shaft having multiple discs, secondary critical speed, critical speeds light cantilever shaft with a large heavy disc at its end.

UNIT– V:
Laplace transformations response to an impulsive input, response to a step input, response to pulse(rectangular and half sinusoidal pulse), phase plane method

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.

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”,JohnWiley 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: Understand the concepts of vibrational analysis
CO2: Understand the concepts of free and forced multi degree freedom systems
CO3: Summarize the concepts of torsional vibrations
CO4: Solve the problems on critical speed of shafts
CO5: Apply and Analyze the systems subjected to Laplace transformationsresponse to different inputs

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IV Year - I Semester		L	T	P	C
		3	0	0	3
OPERATIONS RESEARCH (PE-3)					

Course Objectives:

1. Understand Linear Programming models
2. Interpret Transportation and sequencing problems
3. Solve replacement problems and analyze queuing models
4. Understand game theory and inventory problems
5. Interpret dynamic programming and simulation.

UNIT– I:
INTRODUCTION - definition– characteristics and phases – types of operation research models – applications.
ALLOCATION: 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: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.
THEORY OF GAMES: 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.

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.
INVENTORY CONTROL : Introduction – single item – deterministic models – purchase inventory models with one price break and multiple price breaks – shortages are not allowed – stochastic models – demand may be discrete variable or continuous variable – instantaneous production. Instantaneous demand and continuous demand and no set up cost. ABC & VED Analysis.

UNIT– V:
DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming- capital budgeting problem – 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 – simulation languages.

TEXT BOOKS:

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

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

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

CO1: Understand Linear Programming models.
CO2: Interpret Transportation and sequencing problems.
CO3: Solve replacement problems and analyze queuing models.
CO4: Understand game theory and inventory problems.
CO5: Interpret dynamic programming and simulation.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
UNCONVENTIONAL MACHINING PROCESSES (PE-3)					

Course Objectives:

1. To understand basic concepts of modern machining processes.
2. To explain the principles of ultrasonic machining.
3. To illustrate the elector chemical and chemical machining processes.
4. To apply the principles and procedure of thermal metal removal processes.
5. To illustrate the principles and procedure of electron beam machining, laser beam machining and plasma machining.

UNIT– I:
INTRODUCTION: Need for non-traditional machining methods-classification of modern machining processes considerations in process selection, applications.
ABRASIVE JET MACHINING: Abrasive Jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipment's, process variables, mechanics of material removal, MRR, application and limitations, process capabilities, magnetic abrasive finishing, abrasive flow finishing.

UNIT– II:
ULTRASONIC MACHINING – Elements of the process, mechanics of material removal, effect of process parameters, tool feed mechanisms, economic considerations, recent developments, applications and limitations.

UNIT– III:
ELECTRO–CHEMICAL MACHINING: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate, Electro-stream drilling, shaped tube electrolytic machining.
Fundamentals of chemical machining, advantages and applications.

UNIT– IV:
THERMAL METAL REMOVAL PROCESSES: General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface.

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UNIT– V:
ELECTRON BEAM MACHINING, LASER BEAM MACHINING - Basic principle and theory, mechanics of material removal, process parameters, efficiency & accuracy, applications
PLASMA ARC MACHINING: Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.

TEXT BOOKS:

1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel – Gawad El-Hafy/CRCPress-2016.
2. Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific publications

REFERENCES:

1. Modern Machining Process / Pandey P.C. and Shah H.S./TMH.
2. New Technology / Bhattacharya A/ the Institution of Engineers, India1984.
3. Non Traditional Manufacturing Processes / Benedict

Course Outcomes: At the end of the course, student will be able to
CO1: Understand the concepts of modern machining processes. .
CO2: Learn the principles of ultrasonic machining.
CO3: Apply the principles and procedure of electro chemical and chemical machining processes.
CO4: Apply the principles and procedure of thermal metal removal processes
CO5: Illustrate the principles and procedure of electron beam machining, laser beam machining and plasma machining.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
COMPUTATIONAL FLUID DYNAMICS (PE-3)					

Course Objectives:

1.To explain elementary details and numerical techniques for solving various engineering problems involving fluid flow.
2. To study about finite difference applications in heat conduction and convection.
3. To use finite difference for flow modeling
4. To understand the concepts of finite volume method.
5. To understand the concepts of finite element method applied to heat transfer problems.

UNIT– I:
REVIEW OF EQUATIONS GOVERNING FLUID FLOW AND HEAT TRANSFER: Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations (Derivation), conservation of energy principle, and special forms of the Navier-stokes equations.
APPLIED NUMERICAL METHODS: Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices, TDMA – Algorithms.

UNIT– II:
FINITE DIFFERENCE APPLICATIONS: Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function -vorticity formulation.
Finite difference applications in heat conduction and convection –heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.

UNIT– III:
FINITE DIFFERENCE FOR FLOW MODELING: Discretization, consistency, stability and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT– IV:
FLUID FLOW MODELING: Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative property, the upwind scheme.

FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

UNIT– V:
FINITE ELEMENT METHODS: Introduction – Weighted Residual and Variational Formulations – Rayleigh-Ritz Method – Interpolation – One dimensional and Two dimensional regions – Error Control – Applications of FEM to One dimensional Problems (Steady and Transient) – Two dimensional problems.

TEXT BOOKS:
1**.** Numerical heat transfer and fluid flow/Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics-Basics with applications/John.D.Anderson/McGrawHill.

REFERENCES:
1. Computational Fluid Flow and Heat Transfer/ Niyogi /Pearson Publications
2. Introduction to CFD: Finite Volume Method – H. Versteeg and W. Malalasekahara
3. Fundamentals of Computational Fluid Dynamics /Tapan K. Sengupta/Universities Press.
4.Computational fluid dynamics: An introduction, 3rd edition/John.F Wendt/Springer publishers

Course Outcomes: At the end of the course, student will be able to
CO1: Explain elementary details and numerical techniques for solving various engineering problems involving fluid flow.
CO2: Study about finite difference applications in heat conduction and convection.
CO3: Apply finite difference for flow modeling.
CO4: Understand the concepts of finite volume method.
CO5: Understand the concepts of finite element method applied to heat transfer problems.

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IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
GAS DYNAMICS AND JET PROPULSION (PE-3)					

Course Objectives:

1. To learn basic concepts of compressible fluid flow
2. To learn the isentropic flow of an ideal gas and effects of back pressure on nozzles
3. To learn the simple frictional flow in constant area duct of adiabatic and isothermal flows
4. To learn the conditions to form the shock waves due to the effect of heat transfer in convergent-divergent nozzle
5. To learn the basic concepts of jet propulsions systems and working of liquid propellant engines and Rockets.

UNIT– I:
INTRODUCTION TO GAS DYNAMICS: control volume and system approaches acoustic waves and sonic velocity -Mach number - classification of fluid flow based on Mach number - Mach cone-compressibility factor - general features of one dimensional flow of a compressible fluid - continuity and momentum equations for a control volume.

UNIT– II:
ISENTROPIC FLOW OF AN IDEAL GAS: basic equation - stagnation enthalpy, temperature, pressure and density stagnation, acoustic speed - critical speed of sound- dimensionless velocity-governing equations for isentropic flow of a perfect gas - critical flow area - stream thrust and impulse function.
Steady one dimensional isentropic flow with area change-effect of area change on flow parameters chocking- convergent nozzle - performance of a nozzle under decreasing back pressure -De Lavel nozzle - optimum area ratio effect of back pressure - nozzle discharge coefficients - nozzle efficiencies.

UNIT– III:
SIMPLE FRICTIONAL FLOW: adiabatic flow with friction in a constant area duct-governing equations – Fanno line limiting conditions - effect of wall friction on flow properties in an Isothermal flow with friction in a constant area duct-governing equations - limiting conditions.
Steady one dimensional flow with heat transfer in constant area ducts- governing equations – Rayleigh line entropy change caused by heat transfer - conditions of maximum enthalpy and entropy.

UNIT– IV:
EFFECT OF HEAT TRANSFER ON FLOW PARAMETERS: Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas- properties of flow across a normal shock - governing equations - Rankine Hugoniat equations - Prandtl velocity relationship - converging diverging nozzle flow with shock thickness - shock strength.

UNIT– V:

PROPULSION: Aircraft propulsion - energy flow through jet engines, thrust, thrust power and propulsive efficiency turbojet components- diffuser, compressor, combustion chamber, turbines, exhaust systems (Performance Matching).

Performance of turbo propeller engines, ramjet and pulsejet, scramjet engines. Rocket propulsion – Basic theory of equations - thrust equation - effective jet velocity - specific impulse–rocket engine performance - solid and liquid propellant rockets - comparison of various propulsion systems.

TEXT BOOKS:

1. Compressible fluid flow /A. H. Shapiro / Ronald Press Co., 1953
2. Fundamentals of compressible flow with aircraft and rocket propulsion/S. M. Yahya/New Age international Publishers
3. Fundamental of Gas dynamics-2nd edition/ M J Zucker/ Wiley publishers

REFERENCES:

1. Elements of gas dynamics / HW Liepman &A Roshko/Wiley
2. Aircraft & Missile propulsion /MJ Zucrow/Wiley
3. Gas dynamics / M.J. Zucrow & Joe D.Holfman / Krieger Publishers

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

CO1: Explain elementary details and numerical techniques for solving various engineering problems involving fluid flow.
CO2: Study about finite difference applications in heat conduction and convection.
CO3: Apply finite difference for flow modeling.
CO4: Understand the concepts of finite volume method.
CO5: Understand the concepts of finite element method applied to heat transfer problem

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
AUTOMATION IN MANUFACTURING (PE-4)					

Course Objectives:

1. To understands the types and strategies and various components in Automated Systems
2. To classify the types of automated flow lines and analyze automated flow lines
3. To solve the line balancing problems in the various flow line systems with and without buffer storage
4. To interpret different automated material handling systems, storage and retrieval systems and automated inspection systems
5. To understand the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications.

UNIT– I:
INTRODUCTION: Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, power transmission in CNC machines, optical encoders, other sensors, mechanical feeding and tool changing and machine tool control.

UNIT– II:
AUTOMATED FLOW LINES: Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations, Analysis of automated flow lines - General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

UNIT– III:
ASSEMBLY SYSTEM AND LINE BALANCING: Assembly process and systems, assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.
AUTOMATED INSPECTION: Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision

UNIT– IV:
AUTOMATED MATERIAL HANDLING AND STORAGE SYSTEMS:
Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT– V:
ADAPTIVE CONTROL SYSTEMS: Introduction, adaptive control with optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force, temperatures, vibration and acoustic emission in the adaptive controls systems.

TEXT BOOK:
1.Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover/ PE/PHI.
2.Automation by W. Buekinsham.

REFERENCES:
1. Computer Control of Manufacturing Systems by YoramCoren.
2. CAD / CAM/ CIM by Radhakrishnan.

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

CO1: Understands the types and strategies and various components in Automated Systems.
CO2: Classify the types of automated flow lines and analyze automated flow lines
CO3: Solves the line balancing problems in the various flow line systems with and without buffer storage
CO4: Interpret different automated material handling systems, storage and retrieval systems and automated inspection systems.
CO5: Understand the principles of Adaptive Control systems and recognize the types of automated inspection techniques and their applications

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
POWER PLANT ENGINEERING (PE-4)					

Course Objectives:

1) To learn the working of different components of the steam power plant.
2) To learn the components of the diesel and gas power plants.
3) To learn the different elements in the hydroelectric and nuclear power plants.
4) To learn the basic concepts for power production in combined plants and usage of different instrument to measure the operating parameters of the power plant.
5) To learn the concepts of power plant economics and pollution standards to be observed in the power plants.

UNIT– I:
STEAM POWER PLANT: Plant layout, working of different circuits, fuel and 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, combustion needs and draught system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection, corrosion and feed water treatment.

UNIT– II:
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 spill ways.
HYDRO PROJECTS AND PLANT: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.
NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.
TYPES OF 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.

UNIT– IV:

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.

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.

UNIT– V:

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 – energy audit-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, student will be able to

CO1: Identify the different components of the steam power plant for power production.

CO2: Illustrate the component used in the diesel and gas power plant for power production

CO3: Understand how the power is produced by hydro-electric and nuclear power plants

CO4: Interpret the power production by combined power plants and operating principles of different instruments used in power plants.

CO5: Analyze power plant economics and implementation of pollution standards and control of pollution caused by the power plants.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
BIG DATA ANALYTICS (PE-4)					

Course Objectives:

1) To understand the Big Data Platform and its Use cases
2) To Provide an overview of Apache Hadoop
3) To configure and set the environment with MapReduce
4) To Understand the concepts of Scala programming
5) To understand NoSQL database

UNIT– I:
Introduction to BigData
Introduction: Big Data - Characteristics of Big Data(7Vs) - Big data management architecture - Examining Big Data Types - Big Data Technology Components - Big data analytics- Big data analytics applications and examples- Industries leveraging Big Data, Comparison of Data Characteristics by Industry, Comparison of various Big Data tools, Web Data Overview-Web Data in Action

UNIT– II:
Hadoop
Introduction: History of Hadoop - Hadoop Ecosystem - Analyzing data with Hadoop - Hadoop Distributed File System - Design - HDFS concepts - Hadoop file system - Data flow - Hadoop I / O - Data integrity - Serialization -Setting up a Hadoop cluster-Cluster specification-cluster setup and installation-YARN.

UNIT– III:
MapReduce
Introduction: Understanding MapReduce functions - Scaling out - Anatomy of a MapReduce Job Run - Failures -Shuffle and sort - MapReduce types and formats - features - counters - sorting - MapReduce Applications –Configuring and setting the environment-Unit test with MRunit-localtest.

UNIT– IV:
Spark
Installing spark - Spark applications - Jobs - Stages and Tasks - Resilient Distributed databases - Anatomy of a Spark Job Run - Spark on YARN - SCALA: Introduction - Classes and objects - Basic types and operators - built-in control structures –functions and closures-inheritance.

UNIT– V:
NoSQL Databases
Introduction to NoSQL - MongoDB: Introduction - Data types - Creating - Updating and deleing documents -Querying - Introduction to indexing - Capped collections - Hbase: Concepts - Hbase Vs RDBMS – Creating records-Accessing data-Updating and deleting data-Modifying data-exporting and importing data.

USECASES: Call detail log analysis – Credit fraud alert-Weather forecast.

TEXTBOOKS

1. EMCEducationServices,"DataScienceandBigDataAnalytics:Discovering,Analyzing,Visualizing and Presenting Data",Wiley Publishers, 2015.
2. ImonWalkowiak,"BigDataAnalyticswithR",PackTPublishers,2016.

REFERENCEBOOKS

1. David Loshin,"BigDataAnalytics:FromStrategicPlanningtoEnterpriseIntegrationwithTools,Techniques,NoSQL, and Graph", Morgan Kaufmann/Elsevier Publishers, 2013.
2. BartBaesens,"AnalyticsinaBigDataWorld:TheEssentialGuidetoDataScienceanditsApplications",WileyPublishers,2015.
3. Kim H.Pries, Robert Dunnigan,"Big Data Analytics: APracticalGuideforManagers",CRCPress,2015.

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

CO1: Understand the characteristics of big data and concepts of Hadoop ecosystem.
CO2: Design programs for big data applications using Hadoop components.
CO3: Apply Map reduce programming model to process big data.
CO4: Analyze Spark and its uses for big data processing.
CO5: Apply the concepts of NOSQL databases.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
PRODUCTION PLANNING AND CONTROL (PE-4)					

Course Objectives:

1) To understand the different types of production systems and the internal organization of production planning and control
2) To estimate forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3) To understands the importance and function of inventory and to be able to apply for its control and management
4) To apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning
5) To understand dispatching procedure and applications of computers in production planning and control

UNIT– I:
Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.

UNIT– II:
Forecasting – Importance of forecasting –types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.

UNIT– III:
Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems Introduction to MRP I, MRP II, ERP, LOB (Line of Balance), JIT and KANBAN system.

UNIT– IV:
Routing –definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading. Scheduling policies – techniques, standard scheduling methods.
Line Balancing, aggregate planning, chase planning, expediting, controlling aspects.

UNIT– V:
Dispatching – activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up, applications of computer in production planning and control.

TEXT BOOKS:

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/Partik Jonsson Stig- Arne Mattsson/TataMcGrawHill

REFERENCES:

1. Inventory Control Theory and Practice / Martin K. Starr and David W.Miller/Prentice-Hall
2. Production Planning andControl/Mukhopadyay/PHI.
3. Production Control A Quantitative Approach / John E.Biegel/Prentice-Hall
4. Production Control / Franklin G Moore & Ronald Jablonski/Mc-GrawHill
5. Production and Operations Management/Shailendra Kale/McGraw-Hill
6. Production and Operations Management/Ajay K Garg/McGraw-Hill

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

CO1: To understand the different types of production systems and the internal organization of production planning and control.
CO2: To estimate forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
CO3: To understands the importance and function of inventory and to be able to apply for its control and management.
CO4: To apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning.
CO5: To understand dispatching procedure and applications of computers in production planning and control.

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IV Year -I Semester		L	T	P	C
		3	0	0	3
CONDITION MONITORING (PE-4)					

Course Objectives:
1) To introduce the basics of vibration
2) To analyze vibration measurement and analysis using transducers and mounting methods
3) To understand fault diagnosis and interpret vibration measurements
4) To understand oil and wear debris analysis
5) To interpret Ultrasonic monitoring and analysis

UNIT– I:
BASICS OF VIBRATION: Basic motion: amplitudes, period, frequency, basic parameters: displacement, velocity, acceleration, units (including dB scales) and conversions, Mass, spring and damper concept, Introduction to SDOF and MDOF systems, Natural frequencies and resonance, Forced response.

UNIT– II:
VIBRATION MEASUREMENTS AND ANALYSIS: Transducers and mounting methods, data acquisition using instrumentation recorders/data loggers, time domain signal analysis, orbit analysis, Filters, Frequency domain analysis (Narrow band FFT analysis), Nyquist criteria, Sampling, aliasing, windowing and averaging.

UNIT– III:
FAULT DIAGNOSIS: Interpreting vibration measurements for common machine faults, imbalance, and misalignment, mechanical looseness, bearing and gearing faults, faults in induction motors, resonances, some case studies, static and dynamic balancing, and international standards for vibration condition monitoring.
THERMOGRAPHY: The basics of infrared thermography, differences in equipment and specific wave length limitations, application of IR to: electrical inspection, mechanical inspection, energy conservation, how to take good thermal images, hands-on demonstrations focusing on proper camera settings and image interpretation, analysis of thermal images and report generation, study of thermography applications.

UNIT– IV:
OIL AND WEAR DEBRIS ANALYSIS: Basics of oil analysis, monitoring condition of oil, lubricant analysis, physio – chemical properties, moisture, tan tbn, wear debris analysis, particle counting, spectroscopy, uses & limitations, ferrography wear particle analysis, concept of ferrography, principle particle classification, size, shape, composition, concentration, analysis procedure, sampling & analytical ferrography equipment's, severity rating.

UNIT– V:
ULTRASONIC MONITORING AND ANALYSIS: Ultrasonic monitoring (leak, crack and thickness) basics of ultrasonic monitoring , ultrasonic theory, test taking philosophy, ultrasonic theory, mathematics of ultrasound, equipment and transducers, inspection parameters and calibration, immersion theory, equipment quality control, flaw origins and inspection methods, UT Procedure familiarization, and study recommendations, application of ultrasound to: air leaks, steam trap testing, bearing lubrication, electrical inspection, case studies.

TEXT BOOKS:

1. The Vibration Analysis Handbook/J I Taylor (1994)/Vibration consultants Incorporate Publishers
2. Mohanty, A.R. (2014). Machinery Condition Monitoring: Principles and Practices (1st Ed.). CRC Press.

REFERENCES:

1. Machinery Vibration: Measurement and Analysis/Victor Wowk/Mc GrawHill Professional
2. Mechanical fault diagnosis and condition monitoring/RA Collacott(1977) /Chapman and Hall
3. The Vibration Monitoring Handbook/Charles W Reeves/Coxmoor publishing company

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

CO1: Understand the basics of vibration.
CO2: Analyze vibration measurement and analysis using transducers and mounting methods.
CO3: Understand fault diagnosis and interpret vibration measurements.
CO4: Understand oil and wear debris analysis.
CO5: Interpret Ultrasonic monitoring and analysis.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
ADVANCED MANUFACTURING PROCESSES (PE-5)					

Course Objectives:

1) To understand the principles of various coating techniques and fabrication methods for MEMS devices
2) To make the students understand the properties, processing and design of ceramic and composite materials
3) To understand the fabrication methods for MEMS devices.
4) To understand the concepts and principles of nano manufacturing methods.
5) To learn various Rapid Prototyping (RP) processes and their applications.

UNIT– I:
COATING TECHNIQUES: Scope, Cleaners, Methods of cleaning, Surface coating types, ceramic and organic methods of coating, and economics of coating. Electro forming, Chemical vapor deposition, Physical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT– II:
PROCESSING OF CERAMICS: Applications, characteristics, classification, Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.
PROCESSING OF COMPOSITES: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT– III:
FABRICATION OF MICROELECTRONIC DEVICES: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro-electronics, surface mount technology, Integrated circuit economics.

UNIT– IV:
NANOMANUFACTURING: Nanotubes, Nanoparticles, nanowires, Lithography, Electro-spinning, mechanical milling, Inert gas condensation, sputtering, laser ablation, Arc discharge, Sol-gel methods, working, applications, advantages.

UNIT– V:
RAPID PROTOTYPING: Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing.

TEXT BOOKS:
1. Manufacturing Engineering and Technology*I*Kalpakijian / Adisson Wesley, 1995.
2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.

REFERENCES:
1. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / VanNostrand Renihold,
2. MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
3. Advanced Machining Processes / V.K.Jain / Allied Publications.
4. Introduction to Manufacturing Processes / John A Schey*I*Mc Graw Hill.

Course Outcomes: At the end of the course, student will be able to
CO1: Understand the working principles of various surface coating methods.
CO2: Discuss novel and promising techniques in the processing of ceramics and composites.
CO3: Select suitable fabrication methods for MEMS components.
CO4: Learn the concepts and principles of nano manufacturing methods.
CO5: Illustrate the working principles of RP and select appropriate RP process for the application.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
MECHATRONICS (PE-5)					

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 elector 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 and 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

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 Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/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

CO1: Understand the use the various mechatronics systems, measurement systems, sensors and transducers.

CO2: Apply the concepts of solid state electronic devices.

CO3: Identify the components in the design of electro mechanical systems.

CO4: Apply the concepts of digital electronics and applications of PLCs for control.

CO5:Understand system interfacing, data acquisition and design of mechatronics systems.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3

REFRIGERATION & AIR-CONDITIONING (PE)
(Refrigeration and Psychrometric tables and charts allowed)

Course Objectives:
1) To illustrate the operating cycles and different systems of refrigeration
2) To analyze cooling capacity and coefficient of performance of vapour compression refrigeration systems and understand the fundamentals of cryogenics
3) To calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration system and understand the properties refrigerants.
4) To calculate cooling load for air conditioning systems and identify the requirements of comfort air conditioning
5) To describe different component of refrigeration and air conditioning systems

UNIT– I:
INTRODUCTION TO REFRIGERATION: Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: Bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems.

UNIT– II:
VAPOUR COMPRESSION REFRIGERATION SYSTEM &COMPONENTS: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.
INTRODUCTION TO CRYOGENICS: Joule-Thomson expansion, refrigerant mixtures**,** multi stage vapour compression refrigeration.

UNIT– III:
REFRIGERANTS – Desirable properties – classification - refrigerants –green refrigerants - nomenclature – ozone depletion – global warming.
VAPOR ABSORPTION SYSTEM: Calculation of maximum COP – description and working of NH_3 – water system and Li Br –water (Two shell & Four shell) System, principle of operation three fluid absorption system, salient features.
STEAM JET REFRIGERATION SYSTEM: Working Principle and basic components, principle and operation of thermoelectric refrigerator and vortex tube.

UNIT– IV:
INTRODUCTION TO AIR CONDITIONING: Psychometric properties & processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF- problems, concept of ESHF and ADP temperature.
Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning – requirements of industrial air conditioning, air conditioning load calculations.

UNIT– V:
AIR CONDITIONING SYSTEMS: Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. heat pump – heat sources – different heat pump circuits.

TEXT BOOKS:
1. A Course in Refrigeration and Air conditioning / SC Arora &Domkundwar / Dhanpatrai
2. Refrigeration and Air Conditioning / CP Arora / TMH.

REFERENCES:
1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration /Dossat / Pearson Education.
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH

Course Outcomes: At the end of the course, student will be able to
CO1: Illustrate the operating cycles and different systems of refrigeration.
CO2: Analyze cooling capacity and coefficient of performance of vapour compressionrefrigeration systems and understand the fundamentals of cryogenics
CO3: Calculate coefficient of performance by conducting test on vapour absorption and steam jet refrigeration systems and understand the properties of refrigerants.
CO4: Solve cooling load for air conditioning systems and identify the requirements of comfort air conditioning.
CO5:Demonstrate different components of refrigeration and air conditioning systems.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
ADDITIVE MANUFACTURING (PE-5)					

Course Objectives:
1) To understand the principles of prototyping, classification of RP processes and liquid-based RP systems
2) To understand and apply different types of solid-based RP systems.
3) To understand and apply powder-based RP systems.
4) To understand and apply various rapid tooling techniques.
5) To understand different types of data formats and to explore the applications of AM processes in various fields.

UNIT– I:
INTRODUCTION: Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process.
LIQUID-BASED RAPID PROTOTYPING SYSTEMS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– II:
SOLID-BASED RAPID PROTOTYPING SYSTEMS: Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– III:
POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies. three dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– IV:
RAPID TOOLING: Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting process. Direct rapid tooling: Direct AIM, LOM Tools, and Direct Metal Tooling using 3DP.

UNIT– V:

RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats.

RP APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

TEXT BOOKS:

1.Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/WorldScientific publications

REFERENCES:

1. Rapid Manufacturing / D.T. Pham and S.S. Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press
4. Rapid Prototyping / Chua and Liou

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

CO1: Understand the principles of prototyping, classification of RP processes and liquid-based RP systems.

CO2: Understand and apply different types of solid-based RP systems.

CO3: Apply powder-based RP systems.

CO4: Analyze and apply various rapid tooling techniques.

CO5:Understand different types of data formats and explore the applications of AM processes in various fields.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
NON DESTRUCTIVE EVALUATION (PE-5)					

Course Objectives:

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

UNIT– I:

Introduction to non-destructive testing and industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions.

Radiographic test**,** Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography, neutron ray radiography

UNIT– II:

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection - Effectiveness and Limitations of Ultrasonic Testing.

UNIT– III:

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness, DPI, FPI, Limitations of Liquid Penetrant Testing**.**

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current Testing Effectiveness of Eddy Current Testing

UNIT– IV:

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials , Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test

UNIT– V:
Infrared And Thermal Testing: Introduction and fundamentals to infrared and thermal testing–Heat transfer –Active and passive techniques –Lock in and pulse thermography, tomography-Contact and non-contact thermal inspection methods–Heat sensitive paints –Heat sensitive papers –-thermally quenched phosphors liquid crystals –techniques for applying liquid crystals –other temperature sensitive coatings –Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behaviour of materials–IR imaging in aerospace applications, electronic components, Honey comb and sandwich structures–Case studies.

TEXTBOOKS:

1. Nondestructive test and evaluation of Materials/J Prasad, GCK Nair/TMH Publishers
2. Ultrasonic testing of materials/ H Kraut Kramer/Springer
3. Nondestructive testing/Warren, J Mc Gonnagle / Godan and Breach Science publishers
4. Nondestructive evaluation of materials by infrared thermography / X. P. V. Maldague, Springer-Verlag, 1st edition, (1993)

REFERENCES:

1. Ultrasonic inspection training for NDT/E.A.Gingel/PrometheusPress,
2. ASTMStandards,Vol3.01,Metalsandalloys
3. Non-destructive, Hand Book – R. HamChand

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

CO1: Understand the concepts of various NDE techniques and the requirements of radiographytechniques and safety aspects.
CO2: Interpret the principles and procedure of ultrasonic testing (BL-2).
CO3: Understand the principles and procedure of Liquid penetration and eddy current testing.
CO4: Illustrate the principles and procedure of Magnetic particle testing.
CO5:Interpret the principles and procedure of infrared testing and thermal testing.

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IV Year - I Semester		L	T	P	C
		3	0	0	3
ADDITIVE MANUFACTURING (OE-3)					

Course Objectives:
1) To understand the principles of prototyping, classification of RP processes and liquid-based RP systems
2) To understand and apply different types of solid-based RP systems.
3) To understand and apply powder-based RP systems.
4) To understand and apply various rapid tooling techniques.
5) To understand different types of data formats and to explore the applications of AM processes in various fields.

UNIT– I:
INTRODUCTION: Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process.
LIQUID-BASED RAPID PROTOTYPING SYSTEMS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– II:
SOLID-BASED RAPID PROTOTYPING SYSTEMS: Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– III:
POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies. three dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT– IV:
RAPID TOOLING: Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting process. Direct rapid tooling: Direct AIM, LOM Tools, and Direct Metal Tooling using 3DP.

UNIT– V:
RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats. RP **APPLICATIONS**: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

TEXT BOOKS:
1. Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific publications

REFERENCES:
1. Rapid Manufacturing / D.T. Pham and S.S. Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press
4. Rapid Prototyping / Chua & Liou

Course Outcomes: At the end of the course, student will be able to
CO1: Understand the principles of prototyping, classification of RP processes and liquid-based RP systems.
CO2: Understand and apply different types of solid-based RP systems.
CO3: Apply powder-based RP systems
CO4: Analyze and apply various rapid tooling techniques.
CO5: Understand different types of data formats and explore the applications of AM processes in various fields.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
MECHATRONICS (OE-3)					

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

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

CO1: Understand the use the various mechatronics systems, measurement systems, sensors and transducers

CO2: Apply the concepts of solid state electronic devices.

CO3: Identify the components in the design of electro mechanical systems.

CO4: Apply the concepts of digital electronics and applications of PLCs for control.

CO5: Understand system interfacing, data acquisition and design of mechatronics systems.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
FINITE ELEMENT METHODS (OE-3)					

Course Objectives:
1) To learn basic principles of Variational methods
2) To learn the principles of Weighted residual methods
3) To understand the basic procedure of finite element method
4) To learn finite element modeling of two dimensional analysis
5) To learn the finite modeling using high order and isoparametric elements

UNIT– I:
Introduction to finite element method, variational methods-principles-establishment of natural variational principles, Rayleigh-Ritz method, least squares method.

UNIT– II:
Weighted residual methods, Galerkins method, weighted residual forms, piecewise trail functions, weak formulation, solving differential equations using weighted residual methods, one dimensional problems.

UNIT– III:
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.

UNIT– IV:
Finite element modeling of two dimensional analysis and treatment of boundary conditions. Finite element modeling of four node rectangular element.

UNIT– V:
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.

TEXTBOOKS:
1. An introduction to Finite Element Method /JNReddy/McGraw-Hill

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–KennethH.Huebner, Donald L. Dewhirst, Douglas E. Smith and TedG. Byrom/John Wiley & sons (ASIA)Pvt Ltd.
4. The Finite Element Methods in Engineering /S.S.Rao/Pergamon.

5. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
6. Finite Element Methods / Chen
7. Finite Element Analysis: for students & Practicing Engineers / G.Lakshmi Narasaiah / BSP Books Pvt. Ltd.

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

CO1: Learn basic principles of variational methods
CO2: Learn the principles of Weighted residual methods.
CO3: Understand the basic procedure of finite element method
CO4: Learn finite element modeling of two dimensional analysis
CO5: Learn the finite modeling using high order and isoparametric elements

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
INTRODUCTION TO ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (OE-3)					

Course objectives:
1) To understand the basic concepts of artificial intelligence, neural networks and genetic algorithms.
2) To understand the principles of knowledge representation and reasoning.
3) To gain knowledge about bayesian and computational learning and machine learning.
4) To explore various machine learning techniques.
5) To understand the machine learning analytics and deep learning techniques.

UNIT– I:
Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and environments; Good Behavior-The concept of rationality, the nature of environments, structure of agents.
Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptrons, multilayer networks and back propagation algorithms, Genetic algorithms.

UNIT– II:
Knowledge–Representation and Reasoning: Logical Agents: Knowledge based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification and lifting.

UNIT– III:
Bayesian and Computational Learning: Bayes theorem , concept learning, maximum likelihood, minimum description length principle, Gibbs Algorithm, Naïve Bayes Classifier, Instance Based Learning- K-Nearest neighbour learning
Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real world, classification; differences between supervised and unsupervised learning paradigms.

UNIT– IV:
Basic Methods in Supervised Learning: Distance-based methods, Nearest-Neighbors, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.
Unsupervised Learning: Clustering**,** K-means, Dimensionality Reduction, PCA and kernel.

UNIT– V:
Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods (Boosting, Bagging, and Random Forests).
Modeling Sequence/Time-Series Data and Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

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.

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. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, 1/e, Springer, 2001.
4. Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.
5. M. Narasimha Murty, Introduction to Pattern Recognition and Machine Learning, World Scientific Publishing Company, 2015.

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

CO1: Discuss basic concepts of artificial intelligence, neural networks and genetic algorithms.
CO2: Apply the principles of knowledge representation and reasoning.
CO3: Learn about bayesian and computational learning and machine learning.
CO4: Utilize various machine learning techniques.
CO5: Apply the machine learning analytics and deep learning techniques.

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Year - I Semester		L	T	P	C
		3	0	0	3
OPTIMIZATION TECHNIQUES (OE-4)					

Course Objectives:

1) To understand classification of optimization problem and apply classical optimization techniques
2) To apply unconstrained optimization techniques using various methods
3) To understand the characteristics and approaches of constrained optimization techniques
4) To obtain optimized solutions using constrained and unconstrained geometric programming
5) To understand integer programming methods

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:
INTEGER PROGRAMMING (I.P): Graphical representation. Gomory's cutting plane method. Algorithm for zero-one programming problem. Integer non-linear programming.

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 the course, student will be able to

CO1: Understand classification of optimization problem and apply classical optimization techniques
CO2: Apply unconstrained optimization techniques using various methods
CO3: Understand the characteristics and approaches of constrained optimization techniques
CO4: Identify optimized solutions using constrained and unconstrained geometric programming.
CO5: Understand integer programming methods

IV Year - I Semester		L	T	P	C
		3	0	0	3
SMART MANUFACTURING (OE-4)					

Course objectives:
1) To apply knowledge of smart manufacturing systems' components in the context of Industry 4.0
2) To understand the concepts of smart machines and smart sensors
3) To understand and apply the concepts of IoT connectivity to Industry 4.0
4) To understand the concepts of Digital Twin and apply Machine Learning and Artificial Intelligence concepts in Manufacturing
5) To understand the 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:
Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial 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. Industry 4.0, The Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer

REFERENCES:
1. The Metaverse: And how it will revolutionize everything/Matthew Ball/Liveright Publishers

Course Outcomes: At the end of the course, student will be able to
CO1: Learn about smart manufacturing systems' components and can handle it more effectively in context of Industry 4.0
CO2: Learn about the smart machines and smart sensors
CO3: Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry
CO4: Learn about concepts of Digital Twin and able to apply Machine Learning and Artificial Intelligence concepts in Manufacturing
CO5: Learn the concepts of AR/VR and Metaverse platform

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IV Year - I Semester		L	T	P	C
		3	0	0	3
SAFETY ENGINEERING (OE-4)					

Course objectives:
1) To understand the concepts of industrial safety and management.
2) To demonstrate the accident preventions and protective equipment.
3) To understand and apply the knowledge of safety acts
4) To have the knowledge about fire prevention and protection systems
5) To understand and apply fire safety principles in buildings

UNIT - I

INTRODUCTION TO THE DEVELOPMENT OF INDUSTRIAL SAFETY AND MANAGEMENT: History and development of Industrial safety: Implementation of factories act, Safety and productivity, Safety organizations. Safety committees and structure, Role of management and role of Govt. in industrial safety.

UNIT - II

ACCIDENT PREVENTIONS AND PROTECTIVE EQUIPMENT: Personal protective equipment, Survey the plant for locations, Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Accident reporting, Investigations. Industrial psychology in accident prevention, Safety trials, Safety related to operations.

UNIT - III

SAFETY ACTS: Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act, Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it, Code and regulations for worker safety and health, codes for safety of systems.

UNIT - IV

FIRE PREVENTION AND PROTECTION: Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E- Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station- fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – first aid for burns.

UNIT- V

BUILDING FIRE SAFETY: Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design - exit – width calculations - fire certificates – fire safety requirements for high rise buildings.

TEXT BOOKS:

1) Industrial Maintenance Management Srivastava, S.K. - S. Chand and Co.
2) Occupational Safety Management and Engineering Willie Hammer – Prentice Hall
3) Purandare D.D & Abhay D.Purandare, “Hand book on Industrial Fire Safety” P & A publications, New Delhi, 2006.
4) McElroy, Frank E., “Accident Prevention Manual for Industrial Operations”, NSC, Chicago, 1988.
5) Green, A.E., “High Risk Safety Technology”, John Wiley and Sons, 1984.

REFERENCE BOOKS:

1) Installation, Servicing and Maintenance Bhattacharya, S.N. - S. Chand andCo.
2) Jain V K “Fire Safety in Building” New Age International 1996.
3) Occupational Safety Management and Engineering Willie Hammer – Prentice Hall
4) Reliability, Maintenance and Safety Engineering by Dr. A. K. Guptha
5) A Textbook of Reliability and Maintenance Engineering by Alakesh Manna

Course outcomes:

CO1: Students learn the concepts of industrial safety and management.
CO2: Learn about the smart machines and smart sensors
CO3: Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry
CO4: Students learn about fire prevention and protection systems.
CO5: Students learn and apply the fire safety principles in buildings

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IV Year - I Semester		L	T	P	C
		3	0	0	3
OPERATIONS MANAGEMENT (OE-4)					

Course Objectives:
1) To develop the skills of forecasting, production systems and Aggregate Planning.
2) To provide the knowledge of materials management and scheduling policies
3) To understand the principles of inventory control, MRP and contemporary management techniques.
4) To guide in learning the key concepts and issues of quality management in both manufacturing and service organizations.
5) To develop the knowledge and skill to find out the optimum solutions for a given situation using optimization techniques.

UNIT – I:
Forecasting: Introduction, types of forecasting and their uses, General principles of forecasting, forecasting techniques: qualitative and quantitative methods of Forecasting.
Production Systems: Types of production systems: job, batch, mass and flow type production. **Aggregate Planning:** Introduction, aggregate planning strategies, aggregate planning methods, problems

UNIT – II:
Scheduling: Introduction, difference with loading, scheduling policies, techniques, standard scheduling methods.
Materials Management: Introduction, functions of materials management, inventory, inventory management, types of inventories, Selective inventory control techniques: ABC analysis, VED analysis.

UNIT – III:
Inventory Control: P and Q Systems, Basic Economic Order Quantity model, Price break model, assumptions and problems
Material Requirement Planning: Introduction, Inputs, outputs and MRP logic.
Contemporary management techniques: Introduction to Lean, JIT, ERP and Supply chain Management.

UNIT – IV:
Quality Management: Quality engineering, Taguchi Principles, SQC – X bar, p and c charts, problems, Juran‘s principles Introduction to quality acceptance sampling.
Deming‘s Philosophy, Introduction to Total quality management, Quality Function Deployment, Introduction to six sigma and ISO 9000 2015 standards.

UNIT – V:
Optimization: Linear Programming – Graphical and simplex method – problems, Demonstration of Transportation and Assignment Models, Travelling Salesman problem.

TEXT BOOKS:
1. Modern Production/ operations managements / Baffa & Rakesh Sarin
2. Operations Management – an Integrated Approach, International student Version, R. Dan Reid and Nada R. Sanders, John Wiley & Sons
3. Production and Operations management by K. C. Jain, Wiley
4. Operations Management by William J. Stevenson, McGraw-Hill Companies 2015
5. SOperations Management by Jay Heizer , Barry Render, Chuck Munson , Amit Sachan Twelfth Edition, Pearson, 2017

REFERENCES:
1. Maynard‘s Industrial Engineering Handbook, Kjell B. Zandin, Fifth Edition 2001, The McGraw-Hill Companies, Inc.
2. Operations Management S.N. Chary.
3. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

Course Outcomes: At the end of the course, student will be able to
CO1: Apply appropriate forecasting techniques & Aggregate planning methods
CO2: Learn Materials management analysis and scheduling policies
CO3: Learn about the inventory control techniques, MRP and contemporary management techniques.
CO4: Apply quality management principles proposed by Taguachi, Juran & Demigs
CO5: Apply optimization to LP model & transportation and assignment problems

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		L	T	P	C
IV Year - I Semester		**3**	**0**	**0**	**3**
Universal Human Values: Understanding Harmony					

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IV Year -I Semester		L	T	P	C
		0	0	4	2
MECHATRONICS LAB					

Course Objectives:
1) Measure load, displacement and temperature using analogue and digital sensors.
2) Develop PLC programs for control of traffic lights, water level, lifts and conveyor belts.
3) Simulate and analyze PID controllers for a physical system using MATLAB.
4) Develop pneumatic and hydraulic circuits using Automation studio.

List of Experiments

1. DYNA 1750 Transducers Kit :-
   a. Characteristics of LVDT
   b. Principle & Characteristics of Strain Gauge
   c. Characteristics of Summing Amplifier
   d. Characteristics of Reflective Opto Transducer
2. PLC PROGRAMMING & Simulation of Allen Bradley, Siemens or IEC Ladder Using Automation Studio
   a. Ladder programming on Logic gates ,Timers (TON,TOFF) &counters (UP,DOWN)
   b. Ladder Programming for digital &Analogy sensors
   c. Ladder programming & Simulations of Virtual System such as Traffic Light control, Washing machine, Garage Door, Water level control, Lift control, Conveyor Belt etc.
   d. Ladder programming to control circuits such as single solenoid spring return latch circuit, double solenoid Hydraulic / Pneumatic circuits, Self-Reciprocating Hydraulic / Pneumatic Circuit.
3. AUTOMATION STUDIO SOFTWARE (Design, Simulate & Analyze)
   a. Introduction to Automation studio & its control.
   b. Draw & Simulate Hydraulic circuits for series &parallel cylinders connection, Accumulator circuit, Pressure intensifier circuit, Simple Electro- Hydraulic Electro - Pneumatic circuits (Plot Waveforms for different parameters).
   c. Design & Simulate Meter-in, Meter-out, Regenerative circuit, sequencing circuit, traverse and feed hydraulic circuit, hydraulic press and clamping.
   d. Position Control of Proportional Servo Valve Circuit using PID Feedback controller.
4. MATLAB Programming
   a. Sample programs on Mat lab
   b. Simulation and analysis of PID controller using SIMULINK

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

CO1: Understand the Characteristics of LVDT
CO2: Measure load, displacement and temperature using analogue and digital sensors.
CO3: Develop PLC programs for control of traffic lights, water level, lifts and conveyor belts.
CO4: Simulate and analyze PID controllers for a physical system using MATLAB.
CO5: Develop pneumatic and hydraulic circuits using Automaton studio.

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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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.

		L	T	P	C
MINOR		**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.

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 $Fe\text{-}Fe_3C$.

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 $Fe\text{-}Fe_3C$ system, Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

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.

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:

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.

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.

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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MINOR		L	T	P	C
		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.

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

MINOR		L	T	P	C

	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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	L	T	P	C
	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

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
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

Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial 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**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
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.

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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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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DEPARTMENT OF MECHANICAL ENGINEERING

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

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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

CO 1: Understand 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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

Course Outcomes: At the end of the course, student 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.

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

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.

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.

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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DEPARTMENT OF MECHANICAL ENGINEERING

HONORS		L	T	P	C
		4	0	0	4
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.

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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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 BOOK:
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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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.

<table>
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<tr><td colspan="6">MATERIALS CHARACTERIZATION TECHNIQUES</td></tr>
</table>

Course Objective:

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.

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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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

UNIT – 5

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
		4	0	0	4
ELECTRIC AND HYBRID VEHICLES					

Course objectives: To

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

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

	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.

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**

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:

1) To demonstrate basic concepts of motion controllers, robot 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

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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DEPARTMENT OF MECHANICAL ENGINEERING

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.

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

HONORS		L	T	P	C
		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.

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/ 2^{nd} 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.