INSTITUTE OF ENGINEERING & TECHNOLOGY

DR. RAMMANOHAR LOHIA AVADH UNIVERSITY AYODHYA

EVALUATION SCHEME & SYLLABUS

for

B.TECH. SECOND YEAR

(Admitted in 2021-2022)

MECHANICAL ENGINEERING DEPARTMENT

AS PER

AICTE MODEL CURRICULUM

[Effective from the Session: 2022-23]

Proposed Syllabus for B.Tech. III[rd]&IV[th] Semester for (2022-2023) Session Admitted Student

B.Tech (Mechanical Engineering Department)

Semester III

SEMESTER III													
Sr. No	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	APH301	Technical Communication	2	0	2	30	20	50		100		150	3
2	MET301	Engineering Mechanics	3	0	0	30	20	50		100		150	3
3	MET302	Thermodynamics	3	0	0	30	20	50		100		150	3
4	MET303	Material Science	3	1	0	30	20	50		100		150	4
5	MET304	Fluid Mechanics	3	1	0	30	20	50		100		150	4
6	MEL351	Machine Drawing Lab	0	0	2				25		25	50	2
7	MEL352	Thermodynamics Lab	0	0	2				25		25	50	1
8	MEL353	Material Testing Lab	0	0	2				25		25	50	1
9	MEL354	Fluid Mechanics Lab	0	0	2				25		25	50	1
10	MAB301 /MAB302	Environmental Science/Cyber Security	2	0	0	15	10	25		50		NC+	NC+
11		MOOCs (As per university guideline)											
		Total	**16**	**2**	**10**							**950**	**22**

CT-: Class Test TA-: Teacher Assessment L/T/P-: Lecture/Tutorial/ Practical NC+ -: Non Credit

*Practical Experiment to be included as per Virtual lab Platform.

B.Tech (Mechanical Engineering Department)

Semester IV

Sr. No	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	APS401	Math-IV	3	1	0	30	20	50		100		150	4
2	MET401	Applied Thermodynamics	3	1	0	30	20	50		100		150	4
3	MET402	Strength of Materials	3	0	0	30	20	50		100		150	3
4	MET403	Manufacturing Technology I	3	1	0	30	20	50		100		150	4
5	MET404	Fluid Machinery	3	1	0	30	20	50		100		150	4
6	MEL453	Manufacturing Technology I Lab	0	0	2				25		25	50	1
7	MEL454	Fluid Machinery Lab	0	0	2				25		25	50	1
8	MEL455	Computer Aided Machine Drawing Lab	0	0	2				25		25	50	1
9	MAB402 /MAB401	Cyber Security/ Environmental Science	2	0	0	15	10	25		50		NC+	NC+
10		MOOCs (As per university guideline)											
		Total	**17**	**3**	**6**							**900**	**22**

CT-: Class Test TA-: Teacher Assessment L/T/P-: Lecture/Tutorial/ Practical NC+ -: Non Credit

*Practical Experiment to be included as per Virtual lab Platform.

Engineering Mechanics

L-T-P
3-0-0
MEB301

Course Objectives:
To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering

Unit 1
Force Systems:
Basic concepts and Statics: Definitions, Basic assumptions, Scalar & Vector quantities, Free, Forced and fixed vectors. Force System: Force, Classification & Representation, Force as a Vector, Composition of forces, Parallelogram Law, Resolution, and Principle of Transmissibility of forces Moment of a force, Vector representation, Moment for coplanar force system, Varignon's theorem Couple, Resolution of a force into a force and a couple.-Force Systems: Coplanar Concurrent Force system and Coplanar Non Concurrent force systems, Resultant of coplanar force system. Equilibrium of coplanar force system, free body diagrams, Determination of reactions, Equilibrium of a body under three forces, Lami's theorem.

Friction: Introduction, Wet and Dry friction, Theory of Dry friction, Angle of friction, Angle of Repose. Cone of friction, Coulomb's laws of friction. **10(L)**

Unit 2
Basic Structural Analysis:
Plane Truss, Difference between truss and frame, Perfect and imperfect truss, Assumptions and Analysis of Plane Truss, Method of joints, Method of section, Zero force members. Beams.

Beams: Types of beams, Statically Determinate Beams, Shear force and bending moment in beams, Shear force and bending moment diagrams, Relationships between load, shear and bending moment. **10 (L)**

Unit 3
Centroid and Moment of Inertia:
Center of Gravity, Center of Mass and Centroid of curves, areas, volumes, Determination of centroid by integration, Centroid of composite bodies. Definition of Moment of inertia of area, Perpendicular axis theorem and Polar moment of inertia, Parallel axis theorem, Moment of inertia of simple areas by integration, Moment of Inertia of Composite Areas.Moment of Inertia of masses, Parallel axis theorem for mass moment of inertia, Mass moment of inertia of simple bodies by integration, Mass moment of inertia of composite bodies. **8(L)**

Unit 4
Kinematics of Rigid Body:
Introduction, Absolute motion, Plane rectilinear motion of rigid body, Plane curvilinear Motion of rigid body, x-y and n-t components, Rotation of rigid bodies, Relative Motion, Plane Motion of rigid bodies, Instantaneous center of zero velocity
Kinetics of Rigid Body:
Introduction, Force, Mass and Acceleration, Newton's law of motion, D'Alembert's Principles and Dynamic Equilibrium, Laws of motion applied to planar translation, rotation and plane motion
Concept of virtual work **10(L)**

Concept of virtual work **10(L)**

Unit 5

Mechanics of Deformable Solids:

Simple stress and strain: Normal and shear stresses. One Dimensional Loading; members of varying cross section, bars in series. Stresses in Rotating disc. Tensile Test diagram for ductile and brittle materials. Elastic constants, Generalized Hooks Law , Introduction of 3D stresses, Concept of Strain energy, strain due togradual, sudden and impact loading.

8(L)

Course Outcomes:

CO Number	Course Outcome (Please include all COs of your Course here)
CO1	**Define** the basic parameters related to mechanics in static and dynamic conditions and **draw** corresponding diagrams.
CO2	**Describe** and **explain** general governing equations for various types of elements related to basic physical shape and geometry.
CO3	**Calculate** and **analyze** parameters by the help of conditions of equilibrium, basic governing equations related to moment of inertia, dynamic equilibrium, moment and momentum principles etc.
CO4	**Design** and **compare** various stresses, elastic properties etc. on machine elements like shaft, beams etc.
CO5	**Evaluate** values of shear force, bending moment & stresses and **sketch** corresponding diagrams.

Text Books:

1 Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2 Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

References Books:

1 Engineering Mechanics: Statics J.L Meriam , Wiley
2 Engineering Mechanics: Dynamics J.L Meriam , Wiley
3 Engineering Mechanics: F L Singer
4 Engineering Mechanics: Statics and Dynamics R. C. Hibbler, Pearson
5 Engineering Mechanics: Thimoshenko & Young , 4ed, Tata McGraw Hill
6 Engineering Mechanics: Statics and Dynamics A. Nelason, McGraw-Hill
7 Engineering Mechanics: Statics and Dynamics Shames and Rao, Pearson
8 Engineering Mechanics: Statics and Dynamics S. Rajasekaran and G. Sankarasubramanian, Vikas

E-Portals:

1 https://nptel.ac.in/courses/112103109/
2 https://nptel.ac.in/courses/112103108/

Thermodynamics

L-T-P
3-0-0
MET 301

COURSE OBJECTIVES:

1. To learn about work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about application of I law to various energy conversion devices.
3. To evaluate the changes in properties of substances in various processes.
4. To understand the difference between high grade and low-grade energies and II law limitations on energy conversion.

UNIT I

Review of Fundamental Concepts and Definitions: Introduction- Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Cycle Reversibility Quasi – static Process, Irreversible Process, Causes of Irreversibility Energy and its forms, Work and heat (sign convention), Gas laws, Ideal gas, Real gas, Law of corresponding states, Property of mixture of gases and shaft work.

Zeroth law of thermodynamics: Concept of Temperature and its' measurement, Temperature scales.8(L)

UNIT II

First law of thermodynamics: First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume. Limitations of first law of thermodynamics, PMM-I. Steady flow systems and their analysis, Steady flow energy equation, Boilers, Condensers, Turbine, Throttling process, Pumps etc.8(L)

UNIT III

Second law of thermodynamics: Thermal reservoirs, Energy conversion, Heat engines, Efficiency, Reversed heat engine, Heat pump, Refrigerator, Coefficient of Performance, Kelvin

Planck and Clausius statement of second law of thermodynamics, Equivalence of the two statements. Reversible and irreversible processes, Carnot cycle and Carnot engine, Carnot theorem and its corollaries, Thermodynamic Temperature Scale, PMM-II.

Entropy: Clausius inequality, Concept of Entropy, Entropy change of pure substance in different thermodynamic processes, Tds equation, Principle of entropy increase, T-S diagram, Statement of the third law of thermodynamics. 8(L)

UNIT IV

Availability and Irreversibility: Available and unavailable energy, Availability and Irreversibility, Second law efficiency, Helmholtz & Gibb's function.

Thermodynamic relations: Conditions for exact differentials. Maxwell relations, Clapeyron equation, Joule-Thompson coefficient and Inversion curve. Coefficient of volume expansion, Adiabatic and Isothermal compressibility.8(L)

UNIT V

Pure substance, Property of Pure Substance (steam), Triple point, Critical point, Saturation states, Subcooled liquid state, Superheated vapour state, Phase transformation process of water, Graphical representation of pressure, volume and temperature, P-T, P-V and P-h diagrams, T-S and H-S diagrams, use of property diagram, Dryness factor and it's measurement, processes involving steam in closed and open systems.8(L)

Course Outcomes:

1. After completing this course, the students will be able to apply energy balance to systems and its surroundings.
2. Students can evaluate changes in thermodynamic properties of substances.
3. The students will be able to evaluate the performance of energy conversion devices.
4. The students will be able to differentiate between high grade and low-grade energies.

Books and References:

1. Basic and Applied Thermodynamics by PK Nag, MCGRAW HILL INDIA.
2. Thermodynamics for Engineers by Kroos& Potter, Cengage Learning.
3. Thermodynamics by Shavit and Gutfinger, CRC Press.
4. Thermodynamics- An Engineering Approach by Cengel, MCGRAW HILL INDIA.
5. Basic Engineering Thermodynamics, Joel, Pearson.
6. Fundamentals of Engineering Thermodynamics by Rathakrishnan, PHI.
7. Engineering Thermodynamics by Dhar, Elsevier.
8. Engineering Thermodynamics by Onkar Singh, New Age International.

Material Science

L-T-P
3-1-0
MET 302

COURSE OBJECTIVES:

Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.

UNIT I

Introduction: Importance of materials, historical perspective, Future aspects of engineering materials.

Crystal Structure: brief on BCC, FCC and HCP Structures, coordination number and atomicpacking factors. Bravais lattices, Miller indices, crystal imperfections-point line and surface imperfections. Atomic Diffusion: Phenomenon, Ficks laws of diffusion, factors affecting diffusion.

Ferrous and non- ferrous materials: Properties, Composition and uses of Grey cast iron,malleable iron, SG iron and steel, copper alloys-brasses and bronzes, Aluminum alloys. 8(L)

UNIT II

Mechanical Behavior: Stress-strain diagram showing ductile and brittle behavior ofmaterials,

mechanical properties in plastic range, yield strength off set yield strength, ductility, ultimate tensile strength, toughness, Hardness Tests.

Fracture Creep Fatigue: Fracture: Type I, Type II and Type III. Creep: Description of thephenomenon with examples. Three stages of creep, creep properties, stress relaxation. Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.8(L)

UNIT III

Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation,crystal growth, cast metal structures. Phase Diagram I: Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule.

Phase Diagram: Construction of equilibrium diagrams involving complete and partialsolubility. Iron carbon equilibrium diagram description of phases, solidification of steels and cast irons.8(L)

UNIT IV

Heat Treating of Metals: TTT curves, annealing and its types.Normalizing, hardening, tempering, Martempering, austempering, hardenability, surface hardens methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, agehardening.8(L)

UNIT V

Composite materials: Definition, classification, types of matrix materials & reinforcements.

Ceramics: Structure types and properties and applications of ceramics. Mechanical/ Electricalbehavior and processing of Ceramics.

Plastics: Various types of polymers/ plastics and its applications. Mechanical behavior andprocessing of plastics, Future of plastics. Introduction to Smart materials &Nano-materials and their potential applications.8(L)

COURSE OUTCOME:

Course Outcomes:	After taking this course students should be able to:
CO1	Identify crystal structures for various materials and understand the defects in such structures
CO2	Know the various properties like mechanical and electrical of various materials.
CO3	Know the various types of materials used in engineering.
CO4	Know how to increase the strength of materials.
CO5	Select materials for design and construction.

Reference Books

1. Introduction to Material Science for Engineers" by J F Shackelford
2. Materials Science and Engineering: An Introduction" by William D Callister
3. Fundamentals of Materials Science and Engineering: An Integrated Approach" by William D Callister
4. A Textbook of Material Science" by R K Rajput
5. Material Science and Metallurgy" by A V K Suryanarayana
6. Material Science by KM Gupta

Fluid Mechanics

MET 303
LTP
3-1-0

Course Outcomes:

1. To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
2. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
3. To learn about basic laws and equations used for analysis of static and dynamic fluids.
4. To understand the concept of fluid flow measurement and its applications, types of flows and dimensional analysis.
5. To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.

UNIT I

Properties of Fluids, Fluid Statics, Submerged Bodies and Buoyancy Introduction, Properties of Fluids, Viscosity, Thermodynamic Properties, Compressibility and Bulk Modulus, Surface Tension and Capillarity, Vapour Pressure and Cavitation. Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, Meta-centre, stability of immersed and floating bodies, Introduction to CFD. 8 (L)

UNIT II

Fluid Kinematics and Dynamics Types of fluid flows: Continuum & free molecular flows. Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential.8(L)

UNIT III

Fluid Flow Measurements and Flow through Pipes Potential Flow: source, sink, doublet and half-body. Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, orifice meter, venturimeter and bend meter, notches and weirs, momentum equation and its application to pipe bends. resistance to flow, Minor losses in pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems and pipe networks. 8(L)

UNIT IV

Laminar Flow, Turbulent Flow and Boundary Layer Flow Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, eddy viscosity, mixing length concept and

velocity distribution in turbulent flow over smooth and rough surfaces, Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub-layer, separation and its control. 8(L)

UNIT V

Forces on Submerged Bodies and Compressible Flow Drag and lift, drag on a sphere, a two dimensional cylinder, and an aerofoil, Magnus effect. Similarity Laws: geometric, kinematics and dynamic similarity, undistorted and distorted model studies, Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their significance. 8(L)

Course Outcomes:

After taking this course students should be able to:

1. Identify and obtain the values of fluid properties and relationship between them.
2. Understand stress-strain relationship in fluids, classify their behavior and also establish force balance in static systems.
3. Understand the principles of continuity, momentum, and energy as applied to fluid motions.
4. Ability to analyze fluid flow problems with the application of the momentum and energy equations.
5. Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.

TEXT BOOKS

1. A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Dr. R.K. Bansal, Laxmi Publications (P) Limited, 10th Edition, 2018.
2. A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Er. R.K. Rajput, S. Chand Publications & company Ltd., Revised 5th Edition, 2013.

REFERENCES BOOKS

1. Fluid Mechanics: Fundamentals and Applications (SI Units), Yunus A. Cengel, John M. Cimbala, McGraw-Hill Publications (SIE), 3rd Edition, 2014.
2. Fluid Mechanics, Frank M. White, McGraw-Hill Publications (SIE), 7th Edition, 2011.

e-LEARNING RESOURCES

1. http://www.nptelvideos.in/2012/11/fluid-mechanics.html
2. https://nptel.ac.in/courses/112105171/
3. https://nptel.ac.in/keyword_search_result.php?word=fluid+mechanics

Material Testing Lab

L-T-P
0-0-2
MEL 353

COURSE OBJECTIVES:

To understand the principles and performance characteristics different materials.

To know about material properties.

Experiments on Material Testing

1. Strength test (Tensile/Flexural /Compression) of a given mild steel specimen on UTM with full details and stress versus strain plot on the machine.
2. Impact test of a given mild steel specimen on impact testing machine like Charpy, Izod or both.
3. Hardness test of a given mild steel specimen on using Rockwell and Vickers/Brinell testing machines.
4. Fatigue test of a given mild steel specimen on fatigue testing machine.
5. Creep testof a given mild steel specimen on creep testing machine.
6. Study of NDT (non-destructive testing) methods like magnetic flaw detector, ultrasonic flawdetector, eddy current testing machine, dye penetrant tests.
7. Torsion test of a rod using torsion testing machine.
8. Spring index test on spring testing machine.
9. Experiment on deflection of beam, comparison of actual measurement of deflection with dial gaugeto the calculated one, and or evaluation of young's modulus of beam.

COURSE OUTCOME

The students who have undergone the course will be able to measure various properties of materials.
Perform the strength test of a given mild steel specimen on UTM
Perform the test on impact testing machine like Charpy, Izod or both.
Perform Hardness test of given specimen using Rockwell and Vickers/Brinell testing machines.
Perform Fatigue test on fatigue testing machine.
Perform Creep test on creep testing machine.

Fluid Mechanics Lab

L-T-P
0-0-2
MEL354

Note: Ensure to conduct at least 07 experiments from the list:

1. To verify the momentum equation using the experimental set-up on impact of jet.
2. To determine the coefficient of discharge of an orifice of a given shape. Also to determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter and study the variation of the co-efficient of discharge with the Reynolds number.
4. To calibrate a Venturimeter and study the variation of the co-efficient of discharge with the Reynolds number.
5. To calibrate a bend meter and study the variation of the co-efficient of discharge with the Reynolds number.
6. To draw a flow-net using Electrical Analogy Method.
7. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
8. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
9. To study the variation of friction factor, 'f' for turbulent flow in commercial pipes.
10. To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.
11. To determine Meta-centric height of a given ship model.
12. To determine the head loss for a sudden enlargement
13. To determine the head loss for a sudden Contraction.

Machine drawing LAB

L-T-P
0-0-2
MEL351

Introduction (1 drawing sheet)
Graphics Language, Classification of drawings, Principles of drawing, IS codes formachine drawing, scales, types of lines, section lines, Dimensioning

Orthographic Projections (1 drawing sheet)
Principle of first angle and third angle projection, drawing of machine elements in firstangle projection, selection of views, sectional views

Screwed fasteners (2 drawing sheet)
Thread nomenclature, Forms of thread, Thread series, designation, Representation of threads, Boltedjoints, Locking arrangement of nuts

Keys and Cotters and Pin joint (1 drawing sheet)
Types of keys, Cotter joint or Knuckle joint

Shaft Couplings (1 drawing sheet)
Introduction, Rigid coupling or Flexible coupling

Riveted joints (1 drawing sheet)
Introduction, rivets and riveting, Types of rivet heads, Types of riveted joints, Boiler joint

Assembly Drawing (1 drawing sheet)
Introduction, Engine parts-stuffing box, cross head

Free hand sketching*
Introduction, Need for free hand sketching, Free hand sketching of foundation bolts,studs, pulleys, couplings etc.
* students may be asked to submit the free hand sketching assignment at the end of the semester

THERMODYNAMICS LAB

L-T-P
0-0-2
MEL352

Course Objectives: To understand the principles and performance of various boilers and engines.

List of Experiments: (At least 8 of the following)

1. Study of Fire Tube boiler.
2. Study of Water Tube boiler.
3. Study and working of Two stroke petrol Engine.
4. Study and working of Four stroke petrol Engine.
5. Study and working of two stroke Diesel Engine.
6. Study and working of four stroke Diesel Engine.
7. Determination of Indicated H.P. of I.C. Engine by Morse Test.
8. Prepare the heat balance sheet for Diesel Engine test rig.
9. Prepare the heat balance sheet for Petrol Engine test rig.
10. Study of Velocity compounded steam turbine.
11. Study of Pressure compounded steam turbine.
12. Study of Impulse & Reaction turbine.
13. Study of steam Engine model.
14. Study of Gas Turbine Model.

Course Outcomes: The students who have undergone the course will be able to identify various properties of system.

ENVIRONMENTAL SCIENCE

L-T-P
2-0-0
MAB 301/401

Course Learning Objectives:

1. Create the awareness about environmental problems.
2. Develop an attitude of concern for the environment.
3. Impart basic knowledge about the environment and its allied problems.
4. Acquire skills to help the concerned individuals in identifying and solving environmental problems.
5. Motivate learner to participate in environment protection and environment improvement.

Unit-I

Multidisciplinary nature of Environmental Science: Definition, Scope, Importance and Need of Public Awareness. Structure of Environment.5(L)

Unit-II

Ecosystem: Concept of ecosystem, structure and function of ecosystem, food chain food web and ecological pyramid. Different types of ecosystems (Forest, Grassland & Pond). 6(L)

Unit-III

Natural Resource and associated problems: Use and over exploitation of forest resource, deforestation. Mining and their effects. Use and Overutilization of surface and ground water, Effect of modern agriculture. 6(L)

Unit-IV

Environmental pollution and their effects: Water pollution, Air Pollution, Noise pollution, Soil pollution, Solid waste management. 5(L)

Unit-V

Environmental Protection: Environmental Laws, Role of individual and NOG's in environmental protection, Sustainable development. 6(L)

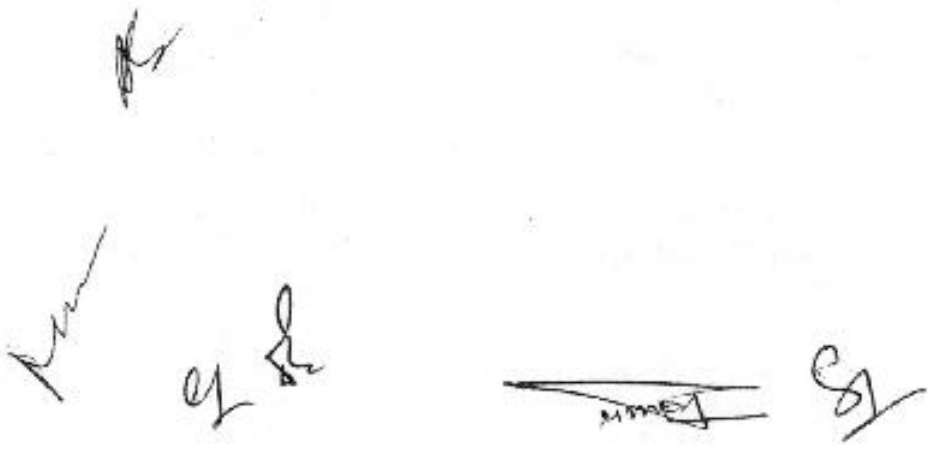
Course Outcome:

CO1: The students can able to make environmentally friendly decision in practical applications.
CO2: The knowledge gained will lead to pollution free environment.
CO3: The current environmental issues can be handled in better way.
CO4: The knowledge of natural resources will lead to have balanced ecosystems.
CO5: Environmental education at different levels will lead to control and protect the ecosystem.

References:

1. BharuchaErach, The biodiversity of India, Mapin Publishing Pvt. Ltd. Ahmedabad.

2. Cunninghum, W. P., Cooper, T. H., Gorhani, E and Hepworth, M.T. 2001. Environmental encyclopedia, Jaico Publ. House, Mumbai.
3. Miller, T. G. Jr Environmental Science system and solution, Web enhanced edition.
4. Sharma, B. K. 2009. Environmental Chemistry, Goel Publ. House.
5. Trivedi, R. K. and P. K. Goel. Introduction to air pollution, Techno-Science Publication



Applied Thermodynamics

L-T-P
3-1-0
MET 401

Course Objectives:

1-To learn about of I law for reacting systems and heating value of fuels.
2- To learn about gas dynamics of air flow and steam through nozzles.
3- To learn the about gas turbine, isotropic efficiency.
4- To analyze the performance of steam turbines.

UNIT I

Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions. Introduction and Otto, Diesel and Dual cycles. **8(L)**

UNIT II

Vapour Power cycles:

Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Rankine cycle, effect of pressure and temperature on Rankine cycle, Reheat cycle, Regenerative cycle, Feed water heaters, Fuels and Combustion: Combustion analysis, heating values, air requirement, Air/Fuel ratio. **8(L)**

UNIT III

Boilers: Classifications and working of boilers, boiler mountings and accessories, Draught and its calculations, air pre-heater, feed water heater, super heater. Condenser: Classification of condenser, air leakage, condenser performance parameters. **8(L)**

UNIT IV

Steam and Gas Nozzles: Flow through Convergent and convergent-divergent nozzles, variation of velocity, area and specific volume, choked flow, throat area, Nozzle efficiency, Off design operation of nozzle, Shock waves stationary normal shock waves, Effect of friction on nozzle, Super saturated flow. **4(L)**

Steam Turbines: Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine. **4(L)**

UNIT V

Gas Turbine: Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with intercooling, reheat and regeneration and their combinations, Stage efficiency, Polytropic efficiency. Deviation of actual cycles from ideal cycles.

6(L)

Course Outcomes:

1. After completing this course, the students will get a good understanding of various practical power cycles and heat pump cycles.
2. They will be able to analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors.
3. They will be able to understand phenomena occurring in high speed compressible flows.

Books and References:

1. Basic and Applied Thermodynamics by P.K. Nag, mcgraw hill india.
2. Applied thermodynamics by Onkar Singh, New Age International.
3. Applied Thermodynamics for Engineering Technologists by Eastop, Pearson Education.
4. Applied Thermodynamics by Venkanna And Swati, PHI.
5. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
6. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
7. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
8. Theory of Stream Turbine by WJ Kearton.

Strength of Material

L-T-P
3-0-0
MET 402

Course objective

1. To provide the basic concepts and principles of strength of materials.
2. To give an ability to calculate stresses and deformations of objects under externalloadings.
3. To give an ability to apply the knowledge of strength of materials on engineeringapplications and design problems.

UNIT I

Compound stress and strains: Introduction, normal stress and strain, shear stress and strain,stresses on inclines sections, strain energy, impact loads and stresses, state of plane stress,

principal stress and strain, maximum shear stress, Mohr's stress circle, three dimensional state of stress & strain, equilibrium equations, generalized Hook's law, theories of failure. Thermal Stresses.8(L)

UNIT II

Stresses in Beams: Pure Bending, normal stresses in beams, shear stresses in beams due totransverse and axial loads, composite beams

Deflection of Beams: Equation of elastic curve, cantilever and simply supported beams,Macaulay's method, area moment method, fixed and continuous beams

Torsion: Torsion, combined bending & torsion of solid & hollow shafts, torsion of thinwalled tubes.8(L)

UNIT III

Helical and Leaf Springs: Deflection of springs by energy method, helical springs underaxial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs.

Columns and Struts: Buckling and stability, slenderness ratio, combined bending and directstress, middle third and middle quarter rules, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling, Ranking Gordon formulae, examples of columns in mechanical equipments and machines.8(L)

UNIT IV

Thin cylinders & spheres: Introduction, difference between thin walled and thick walledpressure vessels, Thin walled spheres and cylinders, hoop and axial stresses and strain, volumetric strain.

Thick cylinders:

Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, compound cylinders, stresses in rotating shaft and cylinders, stresses due to interference fits.8(L)

UNIT V

Curved Beams: Bending of beams with large initial curvature, position of neutral axis forrectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.

Unsymmetrical Bending: Properties of beam cross-section, slope of neutral axis, stress anddeflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.8(L)

Course outcome:

1. Analyze and design structural members subjected to tension, compression, torsion,bending and combined stresses using the fundamental concepts of stress, strain andelastic behavior of materials.
2. Utilize appropriate materials in design considering engineering properties, sustainability,cost and weight.
3. Perform engineering work in accordance with ethical and economic constraints related tothe design of structures and machine parts.

Books and References:

1. Mechanics of Materials by Hibbeler, Pearson.
2. Mechanics of material by Gere, Cengage Learning
3. Mechanics of Materials by Beer, Jhonston, DEwolf and Mazurek, MCGRAW HILL INDIA
4. Strength of Materials by Pytel and Singer, Harper Collins
5. Strength of Materials by Ryder, Macmillan.

Manufacturing Technology I

L-T-P
3-1-0
MET 403

Course Objectives:
To impart basic knowledge and understanding about the primary manufacturing processes such as casting, joining, forming and powder metallurgy and their relevance in current manufacturing industry; To introduce processing methods of plastics

UNIT I
Introduction: Importance of manufacturing. Economic & technological considerations inmanufacturing. Classification of manufacturing processes. Materials & manufacturing processes for common items. **Metal Forming Processes**: Elastic & plastic deformation, yield criteria (Mises' and Tresca's). Hot working versus cold working. Analysis (equilibrium equation method) of Forging process for load estimation with sliding friction, sticking friction and mixed condition for slab and disc. Work required for forging, Hand, Power, Drop Forging.10(L)

UNIT II
Metal Forming Processes (continued): Analysis of Wire/strip drawing and maximum-reduction, Tube drawing, Extrusion and its application. Condition for Rolling force and power in rolling. Rolling mills &rolled-sections. Design, lubrication and defects in metal forming processes.6(L)

UNIT III

Sheet Metal working: Presses and their classification, Die & punch assembly and press workmethods and processes. Cutting/Punching mechanism, Blanking vs. Piercing. Compound vs. Progressive die. Flat-face vs Inclined-face punch and Load (capacity) needed. Analysis of forming process like cup/deep drawing. Bending & spring-back.6(L)

UNIT IV

Casting (Foundry): Basic principle & survey of casting processes. Types of patterns andallowances: Types and properties of moulding sand, sand testing. Elements of mould and design considerations, Gating, Riser, Runnes, Core. Solidification of casting, Sand casting, defects & remedies and inspection. Cupola furnace. Die Casting, Centrifugal casting, Investment casting, Continuous casting, CO2 casting and Stir casting etc.8(L)

UNIT V

Unconventional Metal forming processes: Unconventional metal forming or High EnergyRate Forming (HERF) processes such as explosive forming, electromagnetic, electro-hydraulic forming. **Powder Metallurgy**: Introduction to Powder metallurgy manufacturing process. Application and, advantages. **Jigs & Fixtures**: Locating & Clamping devices & principles. Jigs and Fixtures and its applications.

Manufacturing of Plastic components: Review of plastics, and its past, present & future uses. Injection moulding. Extrusion of plastic section. Welding of plastics. Future of plastic & its applications. Resins & Adhesives.

10(L)

Course Outcomes:

1. To impart knowledge on bulk forming processes
2. To provide understanding of various sheet metal forming and processing of plastics.
3. To provide insight into sand casting and introduce other casting processes
4. To make the students understand fundamental of casting
5. Upon Completion of this course, students will be able to illustrate the concept and application of powder metallurgy process

Text Books:

1. Manufacturing Technology Part I and Part II, - PN. Rao, McGraw-Hill
2. Manufacturing Science – A. Ghosh and AK. Mallik, Affiliated East-West Press
3. Manufacturing Processes for Engineering Materials, - S. Kalpakjian, and Steven R Schmid, Pearson Publication, 5th Edition
4. Fundamental of Modern Manufacturing, MP. Groover, Wiley Publication, 3rd Edition

References Books:

1. Principles of Foundry Technology, Jain, McGraw-Hill
2. Production Technology - R.K. Jain Khanna Publishers.
3. Manufacturing Processes- JP Kaushish , PHI Publication
4. Manufacturing Processes- HS Shan, Pearson Publication

5. Production Technology - PC. Sharma, S. Chand Publication
6. Process & Materials of Manufacturing – R.A. Lindburg, Pearson Eductaion

Web Portal:

https://nptel.ac.in/courses/112107145/

https://nptel.ac.in/courses/112104195/

https://nptel.ac.in/courses/112107144/

Fluid Machinery

L-T-P
3-1-1
MET404

Course Objectives:

1. To give fundamental knowledge of impact ofjet.
2. To impart the knowledge on pumps and turbines.
3. To introduce the concepts of the working and design aspects of hydraulic machines like turbines and pumps and their applications.

UNIT I

Introduction:

Classification of Fluid Machines & Devices, Application of momentum and moment of momentum equation to flow through hydraulic machinery, Euler's fundamental equation.

Impact of Jet:

Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat &curve).

Hydraulic Turbines:

Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Governing of Pelton wheel. **8(L)**

UNIT II

Reaction Turbines:

Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitation in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines. **8(L)**

UNIT III

Centrifugal Pumps:

Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Cavitation & separation, Performance characteristics. **8(L)**

UNIT IV

Positive Displacement and other Pumps:

Reciprocating pump theory, Slip and coefficient of discharge, Indicator diagram, Effect of acceleration, air vessels, Comparison of centrifugal and reciprocating pumps. Positive rotary pumps, Gear and Vane Pumps, Performance characteristics. **8(L)**

UNIT V

Other Machines:

Hydraulic accumulator, Special duty pumps, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift, Theory of hydraulic coupling and torque converters, Performance characteristics.

Water Lifting Devices: Hydraulic Ram, hydraulic coupling, hydraulic torque converter, air lift pump, jet pump. **8(L)**

Course Outcomes:

After taking this course students should be able to:

1. Analyze the forces exerted by a jet of fluid on vanes of different shapes, either stationary or moving.
2. Study and analyze the construction features and working principles of different classes of hydraulic turbines
3. Analyze the performance characteristic curves of hydraulic turbines.
4. Distinguish between different classes of pumps, their construction features and further analyze their performance
5. Understand the working principles of various hydraulic systems, hydraulic control systems and fluidics.

TEXT BOOKS

1. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units),** Dr. R.K. Bansal, Laxmi Publications (P) Limited, 10th Edition, 2018
2. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units),** Er. R.K. Rajput, S. Chand Publications & company Ltd., Revised 5th Edition, 2013.

REFERENCES BOOKS

1. **Hydraulic Machines** by K Subramanya, Tata McGraw Hill
2. **Fluid Mechanics and Machinery** by C.S.P.Ojha, R. Berndtsson, P.N. Chandramouli, Oxford University Press

e-LEARNING RESOURCES

1. Spoken Tutorial MOOC, 'Course onOpenFOAM', IIT Bombay(http://spoken- tutorial.org/)
2. https://nptel.ac.in/courses/112105206/
3. https://nptel.ac.in/keyword_search_result.php?word=hydraulic

Manufacturing Technology I Lab

L-T-P
0-0-2
MEL453

Objectives:

To study and practice the various operations that can be performed in casting, forging, sheet metal working, and powder metallurgy etc. and to equip with the practical knowledge required in the core industries.

List of Experiments: (At least 8 of the following)

Minimum eight experiments out of the following along-with study of the machines /processes

1. Design of pattern for a desired casting.
2. Pattern making with proper allowance.
3. Making a mould (with core) and casting.
4. Sand testing methods (at least one, such as grain fineness number determination)
5. Injection moulding with plastics
6. Forging - hand forging processes
7. Forging - power hammer study & operation
8. Tube bending with the use of sand and on tube bending m/c.
9. Press work experiment such as blanking/piercing, washer, making etc.
10. Wire drawing/extrusion on soft material.
11. Rolling-experiment.
12. Bending & spring back.
13. Powder metallurgy experiment.
14. Any other suitable experiment on manufacturing science / process /technique.
15*.Molding and Casting of Polyurethane parts.
16*. Metal Forming (Upsetting & Extrusion)

Course Outcomes:

Upon completion of this course, the students will able to demonstrate and learn theworking principle of different manufacturing processes, used for the fabrication ofthe objects.

Fluid Machinery Lab

L-T-P
0-0-2
MEL454

Minimum 07 experiments out of the following along with study of the machines and processes

1. Impact of Jet experiment.
2. Experiment on Pelton wheel.
3. Experiment on Francis turbine.
4. Experiment on Kaplan turbine.
5. Experiment on Reciprocating pump.
6. Experiment on centrifugal pump.
7. Experiment on Hydraulic Jack/Press
8. Experiment on Hydraulic Brake
9. Experiment on Hydraulic Ram
10. Study through visit of any water pumping station/plant
11. Any other suitable experiment/test rig such as comparison & performance of different types of pumps and turbines.
12. Experiment on Compressor
13. Experiment for measurement of drag and lift on aerofoil in wind tunnel

Computer Aided Machine Drawing II Lab

L-T-P
0-0-2
MEC 4L3

Objectives:
To provide an overview of how computers can be utilized in mechanical component design.
Note: All drawing conforms to BIS Codes.

Introduction: Conventional representation of machine components and materials, Conventional representation of surface finish, Roughness number symbol, Symbols of Machine elements and welded joints. Classification of Drawings: Machine drawings, Production drawing, part drawing and assembly drawing. Introduction to detail drawing and bill of materials (BOM).

Limits, Fits and Tolerances: General aspects, Nominal size and basic dimensions, Definitions, Basisof fit or limit system, Systems of specifying tolerances, Designation of holes, Shafts and fits, Commonly used holes and shafts. List of Standard Abbreviation used.

Part Modelling: Introduction to part modelling of simple machine components using any 3D software(like CATIA, PRO E, UGNX, Autodesk Inventor or SOLIDWORKS) covering all commands/ features to develop a part model (Minimum 24 machine components need to be developed).

Part Modelling & Assemblies of: Plummer Block Bearing, Machine Vice, Screw Jack, Engine Stuffing box, Lathe Tailstock, Feed Check Valve and Rams Bottom Safety Valve.

Course Outcomes:
Upon completion of this course, the students can use computer and CAD software for modelling mechanical components.

Institute of Engineering and Technology

Dr. Rammanohar Lohia Avadh University, Ayodhya

Evaluation Scheme with Syllabus

for

B. Tech 4th Year

(Admitted in 2021-22)

Mechanical Engineering

on

Choice Based Credit System

(Effective from the session: 2022-23)

EVALUATION SCHEME

B.TECH (MECHANICAL ENGINEERING)

YEAR 4rd/ SEMESTER VII

S. No.	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1.		OPEN ELECTIVE COURSE-1	3	0	0	30	20	50		100		150	3
2.		DEPTT ELECTIVE COURSE-1	3	0	0	30	20	50		100		150	3
3.		DEPTT ELECTIVE COURSE-2	3	0	0	30	20	50		100		150	3
4.	MEC 701	CAD/CAM	3	0	0	30	20	50		100		150	3
5.	MEA 702	Automobile Engineering	3	0	0	30	20	50		100		150	3
6.	MEC 7L1	CAD/CAM Lab	0	0	2				25		25	50	1
7.	MEA 7L2	IC Engine & Automobile Lab	0	0	2				25		25	50	1
8.	MET 7L3	Industrial Training	0	0	3				50			50	1
9.	MEP 7L4	Project Part-I	0	0	4				100			100	2
	TOTAL		**15**	**0**	**11**							**1000**	**20**

OPEN ELECTIVE COURSE-1		
S. No.	**Subject Code**	**Subject**
1.	OE701	Entrepreneurship Development
2.	OE702	Advanced Metal Processes
3.	OE 703	Optimization Method in Engineering
4.	OE 704	*Human Values in Madhyasth Darshan

DEPARTMENTAL ELECTIVE COURSE-1		
S. No.	Subject Code	Subject
1.	MEE 701	Composite Materials
2.	MEE 702	Operation Research
3.	MEE 703	Surface Engineering
4.	MEE 704	Supply Chain Management

DEPARTMENTAL ELECTIVE COURSE-2		
S. No.	Subject Code	Subject
1.	MEE 705	Mechanical System Design

2.	MEE 706	Modelling And Simulation
3.	MEE 707	Automation And Robotics
4.	MEE 708	Project Management

EVALUATION SCHEME B.TECH

(MECHANICAL ENGINEERING)

YEAR 4rd/ SEMESTER VIII

S. No.	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1.		OPEN ELECTIVE COURSE-2	3	0	0	30	20	50		100		150	3
2.		DEPTT ELECTIVE COURSE-3	3	0	0	30	20	50		100		150	3
3.		DEPTT ELECTIVE COURSE-4	3	0	0	30	20	50		100		150	3
5.	MEM 801	Total Quality Management	3	0	0	30	20	50				150	3
6.	MEP 8L2	Project Part-II	0	0	12				150		250	400	6
	TOTAL		12	0	12							1000	18

OPEN ELECTIVE COURSE-2		
S. No.	Subject Code	Subject
1.	OE801	Renewable Energy Resources
2.	OE802	Machine Learning
3.	OE803	Micro and Smart Systems
4.	OE804	*Values, Relationship & Ethical Human Conduct-For a Happy & Harmonious Society
DEPARTMENTAL ELECTIVE COURSE-3		
S. No.	Subject Code	Subject
1.	MEE 801	Power Plant Engineering
2.	MEE 802	Advanced Welding Technology
3.	MEE 803	Non-Destructive Testing
4.	MEE 804	Production Planning and Control
DEPARTMENTAL ELECTIVE COURSE-4		
S. No.	Subject Code	Subject
1.	MEE 805	Additive Manufacturing
2.	MEE 806	Unconventional Machining Processes
3.	MEE 807	Theory of Elasticity and Plasticity
4.	MEE 808	Plant Layout and Material Handling

NOTE:

*** It is mandatory that for these two subjects (OE704 &OE804) only trained faculty (who had done the FDP for these courses) will teach the courses.**

SEMESTER VII

CAD/CAM

L-T-P
3-0-0

MEC701

COURSEOBJECTIVES:

1. To teach the role of CAD/CAM in modern design andmanufacturing
2. To impart the use of CAD in the designprocess
3. To impart the use of CAM in the production preparationprocess
4. Demonstrate the applications and limitations of different CAD/CAM systemtypes

UNIT-I:

Introduction to CAD, Elements of CAD, Essential requirements of CAD, Concepts of integrated CAD/CAM, Necessity & its importance, Engineering Applications Computer Graphics-I CAD/CAM systems, **4(L)**

Principles of Computer Graphics:

Computer Graphics-I Graphics Input devices-cursor control Devices, Digitizers, Keyboard terminals, Image scanner, Speech control devices and Touch, panels, Graphics display devices Cathode Ray Tube, Random & Raster scan display, Color CRT monitors, Direct View Storage Tubes, Flat Panel display, Hard copy printers and plotters, Bresenham's circle algorithm. **5(L)**

UNIT-II:

Graphics standard &Curves: Standards for computer graphics GKS, PHIGS. Data exchange standards – IGES, STEP – Manipulation of the model - Model storage. **4(L)**

Design of curved shapes- Cubic spline – Bezier curve – B-spline – Design of Surfaces - features of Surface Modelling Package – Solid Primitives, CSG **4(L)**

UNIT-III:

Numerical control in CAM:

Definition, Historical background, basic components of NC system, Classification, fundamentals of NC, Procedure, Co-ordinate system, motion control systems, Advantages of NC system; Features of CNC Machine tools, Economics of NCmachiningcenters. **4(L)**

Introduction to automation and need and future on NC systems and CAM. Advantage and disadvantages. Features in NC Machines: Difference between ordinary and NC machine tool. **4(L)**

Computer Numerical Control-Principle of operation of CNC, Features of CNC, and Development in CNC systems, Adaptive Control, Direct Numerical Control (DNC) Standard Communication Interfaces, Programmable Logic Controllers (PLCs) Communication networks, New development in NC.ConstructionalFeatures of CNC Machines: Automatic Tool changers. **5(L)**

UNIT-IV:

NC Part Programming-Manual part programming, computer assisted part programming and CAD based Part Programming.

Feed Back Devices: stepping motors, Feedback devices such as encoder, counting devices, Digital to Analog converter and vice versa;

Interpolators- Principle, Digital Differential Analyzer. Linear Interpolator, Circular Interpolator and itssoftwareinterpolator. **5(L)**

UNIT-V:

Control of NC System-Open and closed loops. Automatic control of closed loops with encoder & tachometers. Speed variation of DC motor. Adaptive control. Computer Integrated Manufacturing System- Manufacturing cell, Transfer lines. FMS,CIM concept. **5(L)**

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

CO1: Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.

CO2: Demonstrate the basic fundamentals that are used to create, manipulate and analyse Geometricmodels in a computer graphics.

CO3: To learn about Robot motions, sensors, end effectors Programming, kinematic analysis of robot.

CO4: Explain the basic concepts, features of NC, CNC, DNC machines and machining centres.

Books and References:

1. Chris Mcmahon and - CAD/CAM – Principle Practice and Manufacturing Management, Jimmie Browne Addision Wesley England, SecondEdition,2000.
2. Dr.Sadhu Singh - Computer Aided Design and Manufacturing, Khanna Publishers, NewDelhi, SecondEdition,2000.
3. P.Radhakrishnan, - CAD/CAM/CIM, New Age International (P) Ltd., New Delhi. S.Subramanayanand V.Raju.
4. Groover M.P. and - CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall Zimmers EW. International, New Delhi,1992.
5. Ibrahim Zeid - CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., Company Ltd., New Delhi,1992.
6. Mikell P.Groover - Automation , Production Systems and Computer IntegratedManufacturing, Second edition, Prentice Hall of India,2002.
7. S.Kant Vajpayee - Principles of Computer Integrated Manufacturing, Prentice Hall ofIndia, 1999.
8. David Bed worth - Computer Integrated Design and Manufacturing, TMH,1998.

AUTOMOBILE ENGINEERING

L T P
3 0 0

MEA 702

Course Objectives:

1-To study basics of principles of actual automobilesystems.
2-To study importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancingetc
3-To study working of various AutomobileSystems.
4-To know some modern trends in AutomotiveVehicles.

UNIT-I

Introduction

Basic concept of automobile engineering and general configuration of an automobile. Power and torque characteristics. Rolling air and gradient resistance. Tractive effort. Gear Box. Gear ratio determination.**7(L)**

UNIT-II

Transmission System:

Requirements Clutches torque converters Over Drives and free wheel Universal joint Differential Gear Mechanism of Rear Axle Automatic transmission steering and front Axel Castoe Angel wheel camber and toe-in Toe-out etc steering geometry ackerman mechanism understeer and oversteer .**8(L)**

UNIT-III

Braking system

General requirement road tyre adhesion weight transfer braking ratio. Mechanical brakes hydraulic brakes vacuum and air brakes thermal aspects**5(L)**

Chasis and suspension system

Loads on the frame strength and stiffness independent front and rear suspension, perpendicular arm type, parallel arm type, dead axis suspension system, live axis suspension system, air suspension & shock absorbers. **5(L)**

UNIT-IV

Electrical system:

Types of starting motors, generator regulators, lighting system, ignition system, horn battery etc. **5(L)**

Fuel supply system:

Diesel & petrol vehicle system such as fuel injection pump injector & fuel pump, carburetorsetc MPFP. **4(L)**

UNIT-V

Emission slandered and pollution control

Indian standard for automotive vehicle-bharatI ,II,III,IV,V and VI norms, fuel quality standards, environmental management system for automotive vehicle, catalytic converters, fuel additives and modern trends in automotive engine efficiency and emission control.

Introduction to Electric &Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact ofmoderndrive-trains on energy supplies, Configuration and PerformanceofElectric Vehicles. **6(L)**

Course outcome

CO1	Understand the basic lay-out of an automobile
CO2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3	Understand the principles of transmission, suspension, steering and braking systems.
CO4	Understand automotive electronics.
CO5	Study latest developments in automobiles.

Text/Reference books:

1. Crouse, W.H., and Anglin, D.L., Automotive Mechanics, Tata McGraw Hill, NewDelhi, 2005.
2. Heitner, J., Automotive Mechanics, Affiliated South West Press, New Delhi,2000.
3. Narang, G.B., Automobile Engineering, Khanna Publishers, New Delhi,2001.
4. Kamaraju Ramakrishna, Automobile Engineering, PHI Learning pvt. Ltd., Newdelhi-2012

CAD/CAM LAB

L-T-P
0-0-2

MEC7L1

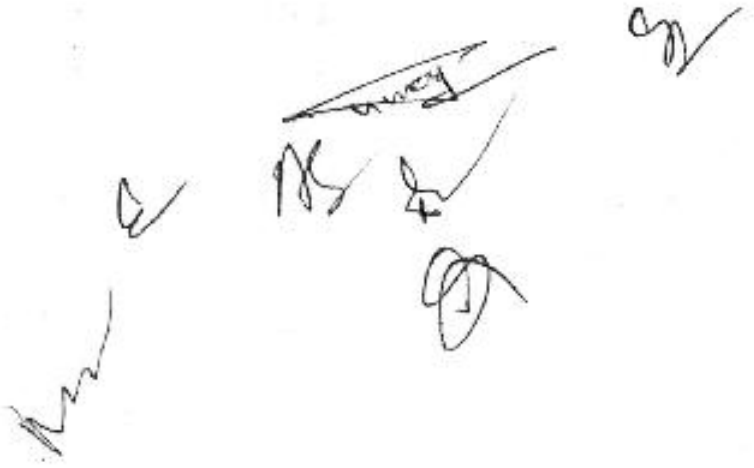
List of Experiments:(Total EIGHT Experiments are to carried out. FOUR Experiments each from CAD and CAM.)

A. CADExperiments:

1. To study Line Drawing or Circle Drawing experiment.
2. To study Geometric Transformation algorithm experiment for translation/rotation/scaling.
3. To study Design of machine component or other system experiment: Writing and validation of computerprogram.
4. Understanding and use of any 3-D Modelling Softwarecommands.
5. To study Pro/E/Idea etc, modeling of a machine component.
6. To study FEM for 2 spring system.

B. CAMExperiments:

1. To study the characteristic features of CNCmachine.
2. To study G code and M code for partProgramming for turning operation..
3. To study Part Programming for drilling operation (point to point) and running on CNCmachine.
4. To study Transfer line/Materialhandling.
5. To studydifference between ordinary and NC machine, study orretrofitting.



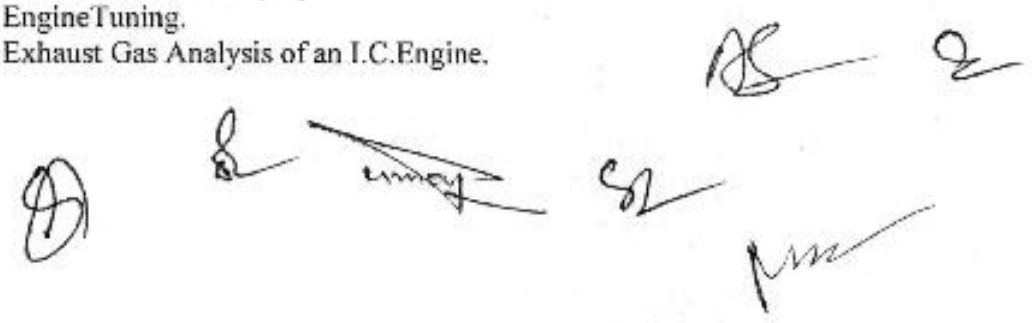
I.C. ENGINES & AUTOMOBILE LAB

L-T-P
0-0-2

MEA7L2

Experiments: Say at least 8 experiments out of following in depth anddetails.

1. Performance Analysis of Four stroke S.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, EnergyBalance.
2. Determination of Indicated H.P. of I.C. Engine by MorseTest.
3. Performance Analysis of Four stroke C.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, EnergyBalance.
4. Study & experiment on Valvemechanism.
5. Study & experiment on GearBox.
6. Study & experiment on Differential Gear Mechanism of RearAxle.
7. Study & experiment on SteeringMechanism.
8. Study & experiment on Automobile BrakingSystem.
9. Study & experiment on Chassis and SuspensionSystem.
10. Study & experiment on Ignition system of I.C.Engine.
11. Study & experiment on Fuel Supply System of S.I. Engines- Carburetor, Fuel Injection Pump andMPFI.
12. Study & experiment on Fuel Supply System of C.I. Engines- Injector & FuelPump.
13. Study & experiment on Air Conditioning System of anAutomobile.
14. Comparative study of technical specifications of common small cars (such as Maruti Swift, Hyundai i20, Chevrolet Aveo, Tata Indica, Ford Fusionetc.
15. Comparative study & technical features of common scooters & motorcycles available in India.
16. Visit of an Automobilefactory.
17. Visit to a Modern AutomobileWorkshop.
18. Experiment on EngineTuning.
19. Experiment on Exhaust Gas Analysis of an I.C.Engine.



OPEN ELECTIVE-1

ENTREPRENEURSHIP DEVELOPMENT

L T P
3 0 0

OE 701

Course Objective: The students develop and can systematically apply an entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.

UNIT-I

Entrepreneurship- definition. growth of small scale industries in developing countries and their positions vis-a-vis large industries; role of small scale industries in the national economy; characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry; stages in starting a small scaleindustry.**8(L)**

UNIT-II

Project identification- assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.**8(L)**

UNIT-III

Accountancy- Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases, advertisement, wages and incentive, inventory control, preparation of financial reports, accounts and stores studies.**8(L)**

UNIT-IV

Project Planning and control: The financial functions cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. Profit planning and programming, planning cash flow, capital expenditure and operations. Control off in axial flows, control and communication. **8(L)**

UNIT-V

Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes and workman compensation act. Role of various national and state agencies which render assistance to small scale industries.**8(L)**

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

CO1	Understand the nature of entrepreneurship
CO2	understand the function of the entrepreneur in the successful, commercial application of innovations

CO3	confirm an entrepreneurial business idea
CO4	identify personal attributes that enable best use of entrepreneurial opportunities
CO5	explore entrepreneurial leadership and management style.

Text books:

1. Forbat, John, "Entrepreneurship" New AgeInternational.
2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New AgeInternational
3. Joseph, L. Massod, "Essential of Management", Prentice Hall ofIndia

ADVANCED METALPROCESSES

LTP3
00

OE 702

Course Objectives: :

To introduce the student to processing of structural materials and materials selection for structural applications using advanced metal processes.

UNIT -I:

Introduction to Manufacturing Processes

a. Discussion inter-relationship of materials and processing withmanufacturing
b. Introduce materials selectioncriterion
c. Introduce materials process selectioncriterion
d. Briefly discuss important physical and mechanical properties of metals andalloys.
e. Examples of structural alloys (e.g., ferrous, non-ferrous, refractory metals,superalloys).

Surfaces

a. Introduce surface finish, wear andlubrication
b. Surface finishmeasurement
c. Wear
d. Lubrication

UNIT -II:

Casting Processes

a. Introduce solidification processing of metals andalloys
b. Solidification
c. Melting of engineeringalloys
d. Casting of ingot andshapes
e. Common casting techniques (e.g., mold, Die Casting centrifugal, squeeze,etc)
f. Advanced casting techniques (e.g., Stir Casting, cooling slope casting of semi-solidetc)

Wrought Processing

a. Discuss deformation processing and it's effect(s) on microstructures andproperties
b. Forging
c. Rolling
d. Extrusion

UNIT -III:

Powder metallurgy processes

a. Discuss design criterion, limitations and advantages of P/Mprocessing

b. Powder makingtechniques
c. Hot working andfabrication
d. Near-net and net-shapeprocessing

UNIT -IV:

Coatings

a. Discuss coatings for improved surfaceproperties
b. Wearresistance
c. Environmentalresistance

Hybrid processes

a. Sprayforming
b. Composites

UNIT-V:

3-D printing

a. Types ofProcesses
b. Cura is an open source slicing application for 3Dprinters.
c. Application inCasting
d. Industrial Applications of 3D Printing (Medical, Automotive, Aerospace,etc)
e. CaseStudies

Course Outcomes:

1. To impart knowledge on structural materials and materials selection bulk forming processes.
2. To understand the properties of various advanced casting and forming processesusing microstructuresanalysis.
3. To provide insight into Surface properties, Coating, powder metallurgy and introduceother Hybridprocesses.
4. To make the students understand fundamental ofcasting.
5. Upon Completion of this course, students will be able to illustrate the conceptand application of 3D Printingprocess.

Text / References book:

1. Manufacturing Science – A. Ghosh and AK. Mallik, Affiliated East-WestPress
2. Manufacturing Processes for Engineering Materials, - S. Kalpakjian, and Steven RSchmid, Pearson Publication, 5thEdition
3. Fundamental of Modern Manufacturing, MP. Groover, Wiley Publication, 3rdEdition
4. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, andDirect Digital Manufacturing by Ian Gibson and David Rosen.
5. Production Technology - R.K. Jain KhannaPublishers.
6. Manufacturing Processes- JP Kaushish , PHI Publication
7. Advances in 3D Printing and Additive Manufacturing Technologies by David Ian Wimpenny and Pulak M Pandey. Understanding Additive Manufacturing, by-Andreas Gebhardt,Hanser
8. Manufacturing Technology Part I and Part II, - PN. Rao,McGraw-Hill
9. Process & Materials of Manufacturing – R.A. Lindburg, Pearson Eductaion.

OPTIMIZATION METHOD IN ENGINEERING

L T P
3 0 0

OE 703

Course Objective:
Introduction to optimization techniques using both linear and non-linear programming. Thefocus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too. After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimizationproblems.

UNIT 1:
Introduction-Optimization Problem Formulation, Design Variables, Constraints, Objective Function, Variable Bounds, Engineering Optimization Problems, Optimization Algorithms. **4(L)**

UNIT 2:
Single Variable Optimization Problems-Optimality Criterion, Bracketing Methods: Exhaustive Search Method, Bounding Phase Method. Region Elimination Methods-Interval Halving Method, Fibonacci Search Method, Golden Section Search Method. Point Estimation Method-Successive Quadratic Estimation Method. Gradient Based Methods-One of the followings-Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method.**8(L)**

UNIT 3:
Multivariable Optimization Algorithms-Optimality Criteria, Unidirectional Search, Direct Search Methods: Any two of the followings-Evolutionary optimization method, Simplex Search Method, Hooke-Jeeves pattern search method, Powell's Conjugate Direction Method.
Gradient Based Methods-Cauchy's Steepest Descent Method. Newton's method, Marquardt's Method. Conjugate Gradient Method, Variable-metric Method.**8(L)**

UNIT 4:
Constrained Optimization Algorithms, Kuhn Tucker Conditions, Transformation Methods-Penalty Function Method, Method of Multipliers. Sensitivity analysis. **5(L)**

UNIT 5:
Specialized Algorithms, Integer Programming-Penalty Function Method, Branch and Bound Method., Geometric Programming. **5(L)**

UNIT 6:
Non-Traditional Optimization Algorithms-Genetic Algorithms,: Simulated Annealing-Analogy, Algorithm, Application and Optimization in Operation Research: Linear Programming,Transportation Problems, & Assignment.**10(L)**

Course outcomes:

1. understand importance of optimization of industrial processmanagement

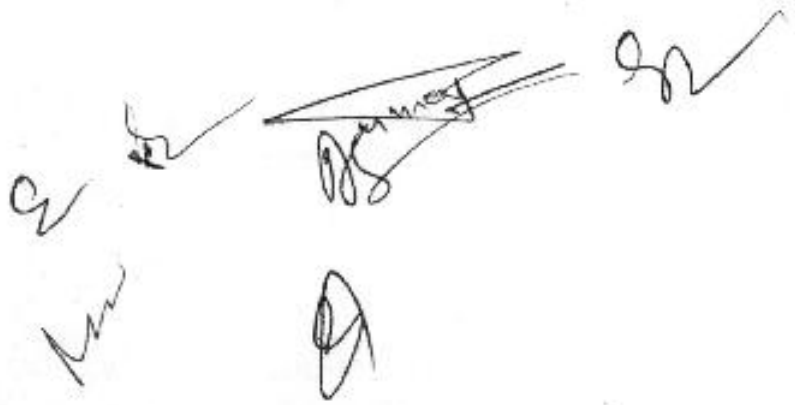
2. apply basic concepts of mathematics to formulate an optimizationproblem
3. analyse and appreciate variety of performance measures for various optimizationproblems
4. Cast engineering minima/maxima problems into optimizationframework.
5. Learn efficient computational procedures to solve optimizationproblems.
6. Ability to bring together and flexibly apply knowledge to characterise, analyse and solvea wide range ofproblems

Text/Reference Books:

1 Kalyanmoy Deb, 2010. Optimization for engineering design: algorithms and examples. Prentice-Hall of India Private Limited, NewDelhi.

2 Singiresu S Rao, 2009. Engineering optimization: theory and practice. Fourth Edition, New Age International(P) Limited Publishers, NewDelhi.

3 A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, 2006. Engineering optimization - methods and applications. Second Edition, John Wiley & Sons, Inc. Andreas Antoniou and Wu-Sheeng Lu,2007. Practical Optimization: Algorithms and applications, Springer Science Business Media,LLC



HUMAN VALUES IN MADHYASTH DARSHAN

L T P
3 0 0

OE 704

Pre requisite: RVE 301/401- Universal Human Values and Professional Ethics

Objectives:

1. To help students understand the basic principles of Madhyasth Darshan
2. To help students understand the existential realities including the human existence through Madhyasth Darshan
3. To help them to see the participation of human beings in the nature/existential realities (i.e. human values) and therefore the human conduct through each one ofthem
4. To help students apply this understanding to make their living better at different levels- individual, family, society andnature
5. To facilitate the students in applying this understanding in their profession and lead an ethical life

Catalogue Description

Madhyasth Darshan is a new emerging philosophy that describes the existential realities along with its implication in behavior and work at the level of individual as well as society. This philosophy has been propounded by Shri A. Nagraj in seventies.

It is to be kept in mind that Darshan means realization which calls for developing the capacity to see the reality in oneself directly. So, any study of Darshan shall help develop this capacity in the students through proper steps of practices and shall not just provide the information. **8(L)**

UNIT-I

Introduction to Madhyasth Darshan and its Basics: Need to study Madhyasth Darshan; introduction, basic formulations of the darshan; the complete expanse of study and the natural outcome of living according to the darshan. **8(L)**

UNIT-II

Submergence of Nature in Space: The ever-present existence in the form of nature submerged in space; nature classified into two categories – material and consciousness, and four orders; the form, property, natural characteristic and self organization of the four orders, General direction and process of evolution in the nature/ existence.**8(L)**

UNIT-III

Human Being as an indivisible part of Nature:

Human being as an indivisible part of nature; various types (five classes)of human beings; human being in the combination of self and body; purpose of self as realization, prosperity for the body; need of behavior and work for attaining the goals of realization andprosperity.**8(L)**

UNIT-IV

Fulfillment of human goal of realization and prosperity: Following natural, social and psychological principles for actualizing the human goal; Form of conducive society and orderfor

such practices, study process- achieving realization through self-study and practice while living in such a society (social order).8(L)

UNIT-V

Human Conduct based on Madhyasth Darshan:

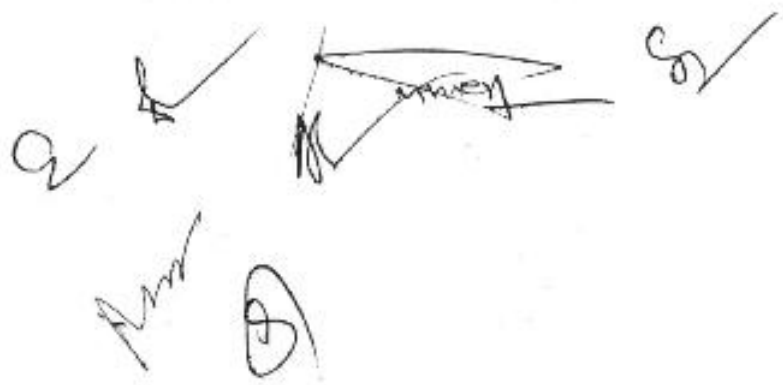
Description of such a realized self, continuity of happiness, peace, satisfaction and bliss through realization, conduct of a realized human being. Possibility of finding solutions to present day problems (such as inequality of rich and poor, man and woman etc.) in the light of it. **8(L)**

Text Books:

1. Nagraj, A., "Manav Vyavahar Darshan", Jeevan Vidya Prakashan, 3rd edition, 2003.

References:

1. Nagraj, A., "VyavaharvadiSamajshastra", Jeevan Vidya Prakashan, 2nd edition,2009.
2. Nagraj, A., "AvartanasheelArthashastra", Jeevan Vidya Prakashan, 1st edition,1998.



DEPARTMENTAL ELECTIVE-1

COMPOSITE MATERIALS

L-T-P
3-0-0

MEE 701

Course Objectives:

1. To make understand the capabilities and limitations of existing materials, processes and property enhancementmechanisms.
2. To understand the fundamentals of composite material strength and itsmechanical behavior.
3. To provide opportunity for improvements, select materials and processes to best suit specific applications.
4. To enhance knowledge on processing, interfacial properties and application of composites.
5. To predict the elastic properties of both long and short fiber composites based on the constituentproperties.

UNIT-I:

Introduction:

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermo sets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.**8(L)**

UNIT-II:

Types of Reinforcements/Fibers:

Role and Selection of reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers,

Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material propertiesthat can be improved by forming a composite material and its engineeringpotential.**8(L)**

UNIT-III:

Various types of composites:

Classification based on Matrix Material: Organic Matrixcomposites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-CarbonComposites, Metal matrix composites (MMC), Ceramic matrix composites (CMC);Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer(FRP) Composites, Laminar Composites, Particulate Composites.**8(L)**

UNIT-IV:

Fabrication methods:

Processing of Composite Materials: Overall considerations, Autoclavecuring, Other Manufacturing Processes like filament welding, compression moulding, resintrans plant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peelplies, release films and fabrics,

Bleeder and breather plies, bagging films, maximum stress and strain criteria, Von Mises Yield criterion for isotropic materials.**8(L)**

UNIT-V:

Testing of Composites and Analysis:

Mechanical testing of composites, tensile testing, Compressive testing,Intra-laminar shear testing, Interlaminar shear testing, Fracture testing etc.Analysis of laminated plates- equilibrium equations of motion, energy formulation, staticbending analysis, buckling analysis, free vibrations, naturalfrequencies.**8(L)**

Course Outcomes:

On completion of the course, student should be able to;

CO1: Analyze the properties of matrix material, particulates and fibers of polymer, metal and ceramic matrix composites.

CO2: Know the mechanism of how a smart works and selection of a smart material for specific applications.

CO3: Solve numerical problems based on micromechanics of composites.

CO4: Select suitable testing procedures, characterization of composite materials and knowledge of secondary processing of composites.

CO5: Select suitable fabrication processes for fiber reinforced, metal matrix composites and ceramic composites.

Books and References:

1. Materials characterization, Vol. 10, ASM handbook.
2. Mechanical Metallurgy, by G. Dieter, McGrawHill.
3. Analysis and Performance of Fiber Composites, by Agarwal, McGrawHill.
4. Thermal Analysis of Materials, by R.F. Speyer, Marcel Decker.
5. Engineering Mechanics and Composite Materials, by Daniels, Oxford UniversityPress.
6. Material Science and Engineering (SIE) with CD, by Smith, McGrawHill.
7. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill,1994.
8. Engineering Materials: Polymers, Ceramics and Composites, by A.K Bhargava Prentice HallIndia.

OPERATIONS RESEARCH

L-T-P
3-0-0

MEE 702

Course Objectives:

1. Impart knowledge of mathematics, basic and appliedsciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis ofresults.
3. Learn effective engineeringcommunication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societalcontext.

UNIT-I:

Introduction:

Basic of Operation Research, Origin & development of Operation Research, Applications.

Linear Programming:

Introduction & Scope, Problem formulation, Graphical Method, Simplex methods, primal and dual problem sensitivity analysis.**8(L)**

UNIT-II:

Transportation Problem:

Methods of obtaining initial and optimum solution, degeneracy intransportation problems, unbalanced Transportation Problem.**4(L)**

Assignment Problem:

Methods of obtaining optimum solution, Maximization problem,travelling salesman problem. **4(L)**

UNIT-III:

Game Theory:

Two-person Zero sum game, Solution with/without saddle point, dominance rule, Different methods like Algebraic, Graphical and game problem as a special case of Linear Programming.

Sequencing:

Basic assumptions, n Jobs through 2-3 machines, 2 Jobs on m machines.**8(L)**

UNIT-IV:

Stochastic inventory models: Single & multi period models with continuous & discrete demands, Service level & reorder policy.

Simulation: Use, advantages & limitations, Monte-Carlo simulation, Application to queuing, inventory& other problems. **8(L)**

UNIT-V:

Queuing models: Characteristics of Queuing Model, M/M/1 and M/M/S system, cost consideration.

Project management: Basic Concept of network Scheduling, Rules for drawing network diagram, Applications of CPM and PERT techniques in Project planning and control; crashing of operations; resource allocation. 8(L)

Course Outcomes: On completion of the course, student should be able to;

CO1: Define models for linear programming

CO2: Convert the linear variable problems to a mathematical model and depict by graphical method.

CO3: Apply artificial variable technique to solve a linear programming model.

CO4: Compute the minimum cost of transportation by Modi's method and Hungarian method.

CO5: Design a project network diagram and schedule the project activities and duration.

CO6: Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

Books and References:

1. Operations Research: Principles and Practice, by- Ravindran, Phillips, Solberg, John Wiley & Sons.
2. Principal of Operation Research, by- Harvey M. Wagner, PrenticeHall.
3. Operations Research - An Introduction, by- Hamdy A. Taha, PearsonIndia.
4. Operation Research, by- Wayne L. Winston, ThomsanLearning.
5. Problems in Operations Research by- Prem Kumar Gupta & D.S. Hira, S.Chand.
6.Operations Research, by Jha, McGrawHill.
7. Operation Research, by Yadav & Malik Oxford University Press.

Surface Engineering

L-T-P
3-0-0
MEE 703

Course Objectives:

Understanding of surface structure and surface engineering basics
Understanding basics of wear and corrosion problems
Understanding the contrasts between different group of surface engineering processes
Industrial applications of different surface engineering technique

Unit– I

Mechanisms of Wear and Metal Cleaning: Basic Mechanisms of wear-abrasive, adhesive wear, contact fatigue, Fretting corrosion, Testing of wear resistance, practical diagnosis of wear, general cleaning process for ferrous and non ferrous metals and alloys selection of cleaning processes, alkaline cleaning, emulsion cleaning, ultrasonic cleaning, pickling salt bath descaling, abrasive bath cleaning, polishing and buffing shot peening. 10(L)

Unit– II

Thermal Spraying Processes and Electrodeposited Coatings: Thermal spraying materials, characteristics of thermal spray processes, Design for thermally sprayed coatings coating production, spray fused coatings, Principles of electroplating, Technology and control electroplating systems, Properties and applications of electrodeposits, Non aqueous and electro less deposition, plasma coating. 9(L)

Unit– III

Hot Dip Coating and Diffusion Coating: Principles, Surface preparation, Batch coating and continuous coating process, Coating properties and application, Principles of cementation, Cladding-vacuum deposition, Sprayed metal coating, Structure of diffusion coatings, Chemical vapour deposition (CVD), Physical vapour deposition (PVD). 9(L)

Unit– IV

Non-Metallic Coating Oxide and Conversion Coatings: Plating coating, lacquers, rubbers and elastomers, viterous enamels, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium copper and silver, phosphating primers. 6(L)

Unit– V

Quality Assurance, Testing and Selection of Coatings: The quality plan, design, testing and inspection, thickness and porosity measurement, selection of coatings, industrial applications of engineering coatings. 6(L)

Course Outcomes:

CO1 Understand the importance, need of surface engineering and review past, present and future status of surface engineering.
CO2 Analyze the factors responsible for damage of the surfaces by corrosion, wear, and wear mechanisms.
CO3 Comprehend the laser processing, electrons & ion beam processing of surfaces, to characterize and evaluate coatings.
CO4 Evaluate economics, energy consumption in designing surface engineering processes.
CO5 Student will be able propose surface engineering technique for target applications

REFERENCE/TEXT BOOKS :

1. Engineering Coatings-design and application- S. Grainger, Jaico PublishingHouse.
2. Principles of Metals surface treatment and protection- D. R. Gabe,Pergamon.
3. Electroplating Handbooks- N.V.Parathasarathy, PrenticeHall.
4. Advances in surface treatment- Niku-Lavi,Pergamon.

SUPPLY CHAIN MANAGEMENT

L-T-P
3-0-0

MEE 704

Course Objectives:

To provide an insight on the fundamentals of supply chain strategy, logistics, sourcing and outsourcing supply chain networks, tools and techniques.

UNIT-I:

Introduction to Supply Chain Management, Understanding the Supply Chain.Supply Chain Performance: Competitive and Supply Chain Strategies, achieving Strategic Fit and Scopeof Strategic Fit.**8(L)**

UNIT-II:

Supply Chain Drivers and Metrics: Drivers of Supply Chain Performance, Framework for structuringDrivers, Facilities, Inventory, Transportation, Information, Sourcing and Pricing, Case Study: Seven-Eleven Japan Company.**8(L)**

UNIT-III:

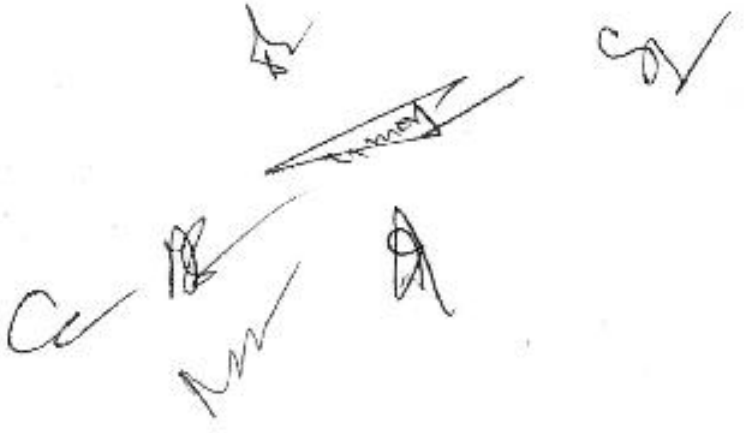
Planning Demand and Supply in a Supply Chain: Demand Forecasting in a Supply Chain, AggregatePlanning in a Supply Chain.
Designing Distribution Networks and Application to E-Business- Role of distribution, factorsinfluencing distribution network design, design options for a distribution network, E-Business and thedistribution network.8(L)

UNIT-IV:
Network Design in the Supply Chain- Role of network design in the supply chain, factors influencingnetwork design decisions, framework for network design decisions.
Role of Information Technology in supply chain, coordination in a supply chain, Bullwhip Effect, Effecton performance due to lack of coordination, obstacles to coordination in a supply chain.8(L)

UNIT-V:
Factors influencing logistics and decisions. Benchmarking and performance measurement. **8(L)**

Course Outcomes:
CO1: Define structure of supply chain
CO2: Design supply chain configuration
CO3: Analyze the role of Transportation in SCM

Books and References:
1. Supply Chain Management: Strategy, Planning & Operation- Sunil Chopra & Peter Meindle-Pearson Prentice Hall Publication.
2. Logistical Management: The integrated Supply Chain Process- Donald J. Bowersox & David J.Closs- TMH Publication.
3. Supply Chain Management – Maretin Christopher.
4. World Class Supply Management: The key to Supply Chain Management- Burt, Dobler and Straling– TMH Publication.
5. Logistics and Supply Management – D K Agarwal – MacMillanPublication
6. Supply Chain Management in the 21st Century- B. S. Sahay- MacMillanPublication.
7. Supply Chain Management: Theories & Practices – R P Mohanty and S. G. Deshmukh-Biztantra Publication.
8. e-Procurement: From Strategy to Implementation- Dale Neef- Prentice HallPublication.



DEPARTMENTAL ELECTIVE-2

MECHANICAL SYSTEM DESIGN

L-T-P
3-0-0

MEE 705

Course objectives:

1. Capstone design objectives—assign students a project that will allow them to integrate a majority of their skills acquired in the last four years regarding both engineering science, design, andcommunication
2. Students will learn and demonstrate both oral and written engineering communication skills 3. Students will consider cost and time constraints (economic considerations) in execution of their designproject
4. Students will consider safety, ethical, and other societal constraints in execution of their designprojects

UNIT – 1

Engineering process and System Approach:

Basic concepts of systems, Attributes characterizing a system, system types, Application of system concepts in Engineering, Advantages of system approach, Problems concerning systems, Concurrent engineering, A case study-Viscous lubrication system in wire drawing.**4(L)**

Problem Formulation:

Nature of engineering problems, Need statement, hierarchical nature of systems, hierarchical nature of problem environment, problem scope and constraint, A case study heating duct insulation system, high speed belt drive system.**4(L)**

UNIT – 2

System Theories:

System Analysis, Black box approach, state theory approach, component integration approach, Decision process approach, A case study-automobile instrumentation panel system.**4(L)**

System modeling:

Need of modelling, Model types and purpose, linear systems, mathematical modeling, concepts, A case study compound bar system. **4(L)**

UNIT – 3

Graph Modeling and Analysis:

Graph Modeling and analysis process, path problem, Network flow problem, A case study: Material handling system.**4(L)**

Optimization Concepts:

Optimization processes, Selection of goals and objectives-criteria, methods of optimization, analytical, combinational, subjective. A case study: aluminum extrusion system.**3(L)**

UNIT – 4

System Evaluation:

Feasibility assessment, planning horizon, time value of money, financial analysis, a case study: Manufacture of maize starch system.**4(L)**

Calculus Method for Optimization:

Model with one decision variable, model with two decision variables, model with equality constraints, model with inequality constraints, A case study: Optimization of an insulation system. **4(L)**

UNIT – 5

Decision Analysis:

Elements of a decision problem, decision making, under certainty, uncertainty risk and conflict probability, density function, expected monetary value, Utility value, Baye's theorem, A case study: Installationofmachinery. **4(L)**

System Simulation: Simulation concepts, simulation models, computer application in simulation, spread sheet simulation, Simulation process, problem definition, input model construction and solution, limitation of simulation approach, a casestudy: Inventory control in production plant.**5(L)**

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

CO1 – Develop an understanding on the use the material data obtained from Standard mechanical testing methods for structural designapplications.
CO2 –Analyse the structural response behavior by breaking the response of structure into axial, bending and torsional deformation modes.
CO3 – Design simple connections for use in structural mechanics.
CO4 –Analyse thermal behavior of structural members.
CO5 – Develop an understanding of experimental mechanics techniques through the use of strain gauge measurements and photo elasticexperiments.

Books/References:-

1. Design and Planning of Engineering systems:- DD Reredith, K V Wong, K W Woodheadand RR Worthman, Prentice Hall Inc., Eaglewood cliffs, NewJerse.
2. Design Engineering:- JR Dixon, TMH, NewDelhi.
3. An introduction to Engineering Design Method:- V Gupta and PN Murthy, TMH, NewDelhi.
4. Engineering Design:- Robert Matousek, Blackie and son ltd.Glasgow
5. Optimization Techniques:- SSRao

MODELLING AND SIMULATION

L-T-P
3-0-0

MEE 706

Course Objective:

The overall aim of the course is to provide an understanding of methods, techniques and tools for modeling, simulation and performance analysis of complex systems

UNIT-I:
Bioinformatics objectives and overviews, Interdisciplinary nature of Bioinformatics, Data integration, Data analysis, Major Bioinformatics databases and tools. Metadata: Summary &reference systems, finding new type of data online. Molecular Biology and Bioinformatics: Systems approach in biology, Central dogma of molecular biology, problems in molecular approach and the bioinformatics approach, overview of the bioinformatics applications.**8 (L)**

UNIT-II:
Basic chemistry of nucleic acids, Structure of DNA, Structure of RNA, DNA Replication, Transcription-Translation, Genes- the functional elements in DNA, Analyzing DNA, DNA sequencing. Proteins: Amino acids, Protein structure, Secondary, Tertiary and Quaternary structure, Protein folding and function, Nucleic Acid-Protein interaction. **8(L)**

UNIT-III:
Perl Basics, Perl applications for bioinformatics- Bio Perl, Linux Operating System, mounting/unmounting files, tar, gzip / gunzip, telnet, ftp, developing applications on Linux OS, Understanding and Using Biological Databases, Overview of Java, CORBA, XML, Webdeploymentconcepts.**8(L)**

UNIT-IV:
Genome, Genomic sequencing, expressed sequence tags, gene expression, transcription factor binding sites and single nucleotide polymorphism. Computational representations of molecular biological data storage techniques: databases (flat, relational and object oriented), and controlled vocabularies, general data retrieval techniques: indices, Boolean search, fuzzy search and neighboring, application to biological datawarehouses.**8 (L)**

UNIT-V:
Macromolecular structures, chemical compounds, generic variability and its connection to clinical data. Representation of patterns and relationships: sequence alignment algorithms, regular expressions, hierarchies and graphical models, Phylogenetics. BLAST.**8(L)**

Course Outcomes: After the successful completion of the course, the students will be able to:
CO1- Describe the role of important elements of simulation and modeling.
CO2- Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
CO3- Simulation technique is use to construct and execute goal-driven problem.
CO4- Interpret the model and apply the results to resolve critical issues in a real world environment.
CO5-Understanding and Using the Biological Databases

Books and References:
1. D E Krane & M L Raymer," Fundamental concepts of Bioinformatics", Perason Education.
2. Rastogi, Mendiratta, Rastogi, "Bioinformatics Methods & applications, Genomics, Proteomics &
3. Drug Discovery" PHI, New Delhi.

4. Shubha Gopal et.al. "Bioinformatics: with fundamentals of genomics and proteomics", Mc GrawHill.
5. O'Reilly, "Developing Bio informatics computer skills",CBS.
6. Simulation Model Design& execution by Fishwich, Prentice Hall,1995.
7. Discrete event system simulation by Banks, Carson, Nelson andNicol.
8. Averill M. Law, W. David Kelton, "Simulation Modelling and Analysis", TMH.
9. Forsdyke, "Evolutionary Bioinformatics", Springer.

AUTOMATION AND ROBOTICS

L-T-P
3-0-0

MEE 707

Course Objective:

1. To study the various parts of robots and fields ofrobotics.
2. To study the various kinematics and inverse kinematics ofrobots.
3. To study the Euler, Lagrangian formulation of Robotdynamics.
4. To study the trajectory planning forrobot.
5. To study the control of robots for some specificapplications.

UNIT- I:
Automation:
Definition, Advantages, goals, types, need, laws and principles of Automation. Elements of Automation. Fluid power and its elements, application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems, Role of Robotics in Industrial Automation.**8(L)**

UNIT- II:
Manufacturing Automation:
Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multi model and mixed model production lines. Programmable Manufacturing Automation CNC machine tools, Machining centres. **8(L)**

UNIT- III:
Robotics:
Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Power Source. Robot anatomy, configuration of robots, joint notation schemes, work volume, manipulate or kinematics, position representation, forward and reverse transformations, homogeneous transformations in robot kinematics, D-H notations.**8(L)**

UNIT -IV:
Robot Drives and Power Transmission Systems:

Robot drive mechanisms: Hydraulic / Electric / Pneumatics, servo & stepper motor drives, Mechanical transmission method: Gear transmission, Belt drives, Rollers, chains, Links, Linear to Rotary motion conversion, Rotary-to-Linear motion conversion. **8(L)**

UNIT- V:

Robot Simulation:

Methods of robot programming, Simulation concept, Off-line programming, advantages of offline programming. **2(L)**

Robot Applications:

Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Limitation of usage of robots in processing operation. **6(L)**

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

CO1-Explain the basic concepts of working of robot
CO2-Analyze the function of sensors in the robot
CO3-Write program to use a robot for a typical application
CO4-Use Robots in different applications

Books and References:

1. An Introduction to Robot Technology, by CoifetChirroza, KoganPage.
2. Robotics for Engineers, by Y. Koren, McGrawHill.
3. Robotic: Control, Sensing, Vision and Intelligence, by Fu, McGrawHill.
4. Introduction to Industrial Robotics, by Nagrajan, PearsonIndia.
5. Robotics, by J.J. Craig,Addison-Wesley.
6. Industrial Robots, by Groover, McGrawHill.
7. Robotic Engineering - An Integrated Approach : Richard D. Klafter ThomasA.
8. Robots & Manufacturing Automation, by Asfahl,Wiley.

PROJECT MANAGEMENT

L T P
3 0 0
MEE 708

Course bjective:

To enable the students to implement project management knowledge, processes, lifecycle andthe embodied concepts, tools and techniques in order to achieve projectsuccess.

UNIT-I

Project Management Concepts

Introduction, project characteristics, taxonomy of projects, project identification and formulation. Establishing the project and goals. Nature & context of project management; phases of PM, A framework for PM issues, PM as a conversion process, project environment &

complexity. Organizing human resources, organizing systems & procedures for implementation. Projectdirection.**8(L)**

UNIT-II

Project Organization & Project Contracts

Introduction, functional organization, project organization, matrix organization, modified matrix organization, pure project organization, selection of project organization structure, project breakdown structures, project contracts, types of contracts, types of payments to contractors.**8(L)**

UNIT-III

Project Appraisal & Cost Estimation

Introduction, technical appraisal, commercial appraisal, economic appraisal, financial appraisal, management appraisal, social cost/benefit analysis, project risk analysis. Cost analysis of the project, components of capital cost of a project, modern approach to project performance analysis.**8(L)**

UNIT-IV

Project Planning & Scheduling

Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, event slacks & floats, PERT model, expected time for activities ,expected length of critical path, calculating the project length and variance, PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique.**8(L)**

UNIT-V

Modification & Extensions of Network Models

Complexity of project scheduling with limited resources, resource leveling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking- examples with algorithm, decision networks, probabilistic networks, and computer aided project management essential requirements of PM software, software packages for CPM. Enterprise-wide PM, using spread sheets for financial projections.**8 (L)**

Course outcomes:

After learning the course the students should be able:

CO1	To make them understand the concepts of Project Management for planning to execution of projects
CO2	To adapt projects in response to issues that arise internally and externally.
CO3	To Interact with team and stakeholders in a professional manner, respecting differences, to ensure a collaborative project environment.
CO4	To Utilize technology tools for communication, collaboration, information management, and decision support.

Books and References :

1. Project Management by Harvey Maylor, PearsonIndia
2. Project Management by Choudhury, McGrawHill
3. Project Management by K.Nagarajan
4. Management: A Systems Approach to Planning, Scheduling and Controlling, by Kerzner, Willey

SEMESTER VIII

TOTAL QUALITY MANAGMENT

L-T-P
3-0-0

MEM 801

Course Objective:

1. Develop an understanding on the necessary information and skills needed to manage,control and improve quality practices in the organizations through TQMphilosophy.
2. Explain the four revolutions in management thoughtprocesses.
3. Apply the reactive and proactive improvement methodologies for problem solvingin organizations.
4. Demonstrate the importance of team work in problem solvingprocesses.
5. Define the business excellence models implemented in variousorganizations.

UNIT -I:

Quality Concepts:

Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design.

Control on Purchased Product:

Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

Manufacturing Quality:

Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims.**8(L)**

UNIT -II:

Quality Management:

Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, seduction programme.**4(L)**

TQM Principles:

Leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S,Kaizen; Supplier partnership, Partnering, Supplier rating & selection.**4(L)**

UNIT -III:

Tools and Techniques:

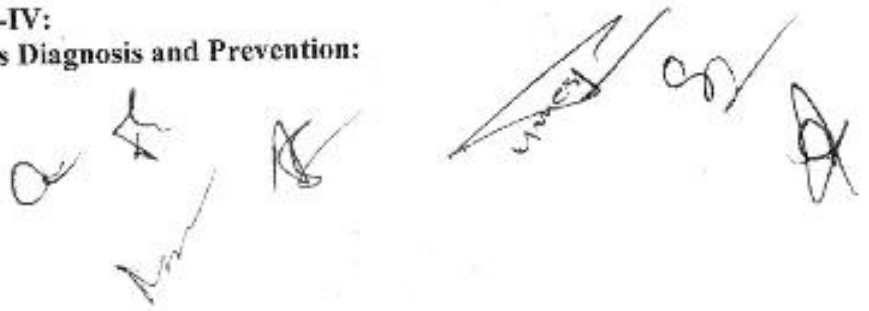
Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Control chart, flow chart).

Control Charts:

Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts, P-charts and C-charts.**8(L)**

UNIT -IV:

Defects Diagnosis and Prevention:



Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.8(L)

UNIT-V:

IS0and its concept of Quality Management:

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors, Auditing, Taguchi method, JIT in some details.8(L)

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

CO1 - Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.

CO2 - Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.

CO3 - Critically appraise the organisational, communication and teamwork requirements for effective quality management

CO4 - Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans

Books and References:

1. Total Quality Management, by Dale H. Besterfield, PearsonIndia.
2. Beyond Total Quality Management, Greg Bounds, McGrawHill.
3. Besterfield D.H. et al., Total qualityManagement, 3rd ed., Pearson Education Asia,2006.
4. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., firstIndian edition, Cengage Learning,2012.
5. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India,2006.
6. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India,2006.
7. Total Quality Management by Mukherjee,P.N.
8. TQM in New Product manufacturing, H. G. Menon, McGrawHill.

OPEN ELECTIVE-2

RENEWABLE ENERGY RESOURCES

L T P
3 0 0

OE 801

Course Objective:

1. You have profound knowledge in a special field such as solar energy, storage, smartgrid.
2. You are able to use laboratories and emulators of renewable energy systems toanalyze relevantissues.
3. You should be used to working in interdisciplinarygroups.

UNIT-I

Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations. **8(L)**

UNIT-II

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.8(L)

UNIT-III

Geothermal Energy: Resources of geothermal energy, thermodynamics of geothermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. **Magneto-hydrodynamics (MHD):** Principle of working of MHD Power plant, performance and limitations.

Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.**8 (L)**

UNIT-IV

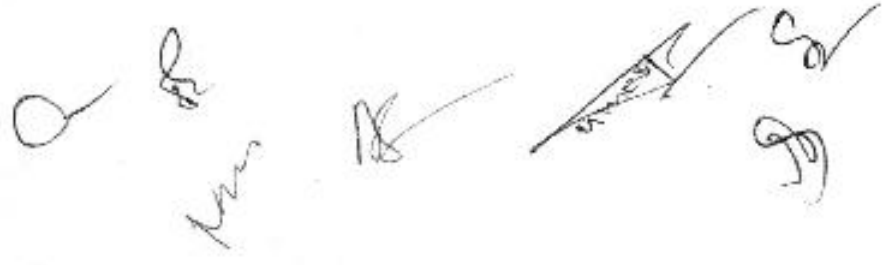
Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentration sand augments, wind characteristics. Performance and limitations of energyconversionsystems.**8(L)**

UNIT-V

Bio-mass: Availability of bio-mass and its conversion theory.

Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations.

Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.**8(L)**



Course Outcomes: At the end of the course, the student will be able to:
CO1 - Ability to recognize the need of renewable energy technologies and their role in the Greece and world energy demand.
CO2 - Knowledge of the operating principles of renewable energy production from various renewable sources
CO3 - Ability to compare the advantages and disadvantages of various renewable energy technologies and propose the best possible energy conversion system for a particular location.

Text books:
1. Raja etal, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
2. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications,2006.
3. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional" BSP Publications,2006.
4. D.S. Chauhan,"Non-conventional Energy Resources" New AgeInternational.
5. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
6. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.

MACHINE LEARNING

L T P
3 0 0

OE 802

Course Objectives:
Students will try to learn:
1. To introduce students to the basic concepts and techniques of Machine Learning.
2.To become familiar with ANN methods, classification methods, clustering methods.
3.To become familiar with Dimensionality reduction Techniques.

UNIT-I
Introduction – Well defined learning problems, designing a Learning System, Issues in Machine Learning;
The Concept Learning Task -General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias**8(L)**

UNIT-II
Decision Tree Learning - Decision tree learning algorithm-Inductive bias- Issues in Decision treelearning;
Artificial Neural Networks –Perceptrons, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of back propagation rule Back propagation Algorithm Convergence,Generalization;**8(L)**

UNIT-III
Evaluating Hypotheses: Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms;

Bayesian Learning: Bayestheorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm;**8(L)**

UNIT-IV

Computational Learning Theory: Sample Complexity for Finite Hypothesis spaces, Sample Complexity for Infinite Hypothesis spaces, The Mistake Bound Model of Learning; **Instance-Based Learning** – k-Nearest Neighbour Learning, Locally Weighted Regression, Radial basis function networks,Casebasedlearning**8(L)**

UNIT-V

Genetic Algorithms: an illustrative example, Hypothesis space search, Genetic Programming, Models of Evolution and Learning; Learning first order rules sequential covering algorithms-General to specific beam search-FOIL;REINFORCEMENT LEARNING - The Learning Task, QLearning.**8(L)**

Course Outcomes:

Students will be able to:

CO1. Gain knowledge about basic concepts of Machine Learning
CO2. Identify machine learning techniques suitable for a given problem
CO3. Solve the problems using various machine learning techniques
CO4. Apply Dimensionality reduction techniques.
CO5. Design application using machine learning techniques.

Text books:

1. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press2004.
3. Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC Press,2009.
4. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.

MICRO AND SMART SYSTEMS

LTP3
00

OE 803

Course Objective: Understand Microsystems versus MEMS, Analyze micro sensors, actuators, systems and smart materials, Evaluate Micromachining technologies, To learn Modeling of solids in, Analysis Integration of micro and smartsystems.

UNIT-I

Introduction, Why miniaturization?, Microsystems versus MEMS, Why microfabrication?, smart materials, structures and systems, integrated Microsystems, applications of smart materials and Microsystems.**8(L)**

UNIT-II

Micro sensors, actuators, systems and smart materials: Silicon capacitive accelerometer, piezo resistive pressure sensor, conducto metric gas sensor, an electrostatic combo-drive, a magnetic micro relay, portable blood analyzer, piezoelectric inkjet print head, micromirror array for video projection, smart materials and systems.**8(L)**

UNIT-III

Micromachining technologies: silicon as a material for micro machining, thin film deposition, lithography, etching, silicon micromachining, specialized materials for Microsystems, advanced processes for micro fabrication.**8(L)**

UNIT-IV

Modeling of solids in Microsystems: Bar, beam, energy methods for elastic bodies, heterogeneous layered beams, bimorph effect, residual stress and stress gradients, poisson effect and the anticlastic curvature of beams, torsion of beam sand shear stresses, dealing with large displacements, In-plane stresses, Modelling of coupled electromechanical systems: electrostatics, Coupled Electro-mechanics: statics, stability and pull-in phenomenon, dynamics. Squeezed film effects in electromechanics.**8(L)**

UNIT-V

Integration of micro and smart systems: integration of Microsystems and microelectronics, micro systems packaging, case studies of integrated Microsystems, case study of a smart-structure in vibration control. Scaling effects in Microsystems: scaling in: mechanical domain, electrostatic domain, magnetic domain, diffusion, effects in the optical domain, biochemical phenomena.**8(L)**

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

CO1	Understand the Why miniaturization?, Microsystems versus MEMS, Why micro fabrication.
CO2	Design Silicon capacitive accelerometer, piezo-resistive pressure sensor, conductometric gas sensor.
CO3	Realizesilicon as a material for micro machining, thin film deposition, lithography,etching, silicon micromachining.
CO4	Understand bar, beam, energy methods for elastic bodies, heterogeneous layered beams, bimorph effect, residual stress and stress gradients, poisson effect and the anticlastic curvature of beams
CO5	Understand integration of Microsystems and microelectronics, microsystems packaging, case studies of integrated Microsystems

Text books:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat and V. K. Atre, "Micro and smart systems", Wiley India, 2010.

VALUES, RELATIONSHIP & ETHICAL HUMAN CONDUCT–FOR A HAPPY & HARMONIOUS SOCIETY

L T P 3 0 0

OE 804

Pre-requisites-for this subject only those faculty will teach these courses who had done the FDP for these courses.

Course Objectives:

1. To help the students to understand the importance and types of relationship with expressions.
2. To develop the competence to think about the conceptual framework of undivided society as well as universal humanorder.
3. To help the students to develop the exposure for transition from current state to the undivided society and universal humanorder.

Course Methodology:

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. It is free from any dogma or set of do's and don'ts related tovalues.
3. It is a process of self-investigation and self-exploration, and not of givingsermons. Whatever is found as truth or reality is stated as a proposal and thestudents are facilitated and encouraged to verify it in their own right, based ontheir Natural Acceptance and subsequent Experiential Validation.
4. This process of self-exploration takes the form of a dialogue between the teacherand the students to begin with, and then to continue within the student leading tocontinuous self-evolution.
5. This self-exploration also enables them to critically evaluate their preconditioning and present beliefs.

UNIT-I

Introduction to the course: Basic aspiration of a Human Being and programfor its fulfillment, Need for family and relationship for a Human Being, Human-humanrelationship and role of behavior in its fulfillment, Human-rest of Naturerelationship and role of work in its fulfillment, Comprehensive Human Goal,Need for Undivided Society, Need for Universal Human Order, an appraisal ofthe Current State, Appraisal of Efforts in this Direction in Human History.**10(L)**

UNIT-II

Understanding Human-Human Relationship & its fulfillment: Recognitionof Human-Human Relationship, Recognition of feelings in relationship,Established Values and Expressed Values in Relationship, interrelatedness offeelings and their fulfillment, Expression of feelings, Types of relationship andtheir purpose, mutual evaluation in relationship, Meaning of justice inrelationship, Justice leading to culture, civilization and Human Conduct.**8(L)**

UNIT-III

Justice from family to world family order: Undivided Society as continuityand expanse of Justice in behavior – family to world family order, continuity ofculture and civilization, Universal Order on the basis of Undivided Society,Conceptual Framework for Universal human order, Universal Human Order ascontinuity and expanse of order in living: from family order to world familyorder, a conceptual framework for universal humanorder.**8(L)**

UNIT-IV

Program for Ensuring Undivided Society and Universal Human Order: Education –Sanskar, Health – Sanyam, Production-work, Exchange – storage,Justice-preservation.**6(L)**

UNIT-V

Human Tradition: Scope and Steps of Universal Human Order, Human Tradition (Ex. Family order to world family order), Steps for transition from thecurrent state, Possibilities of participation of students in this direction, Presentefforts in this direction, Sum up.**8(L)**

Text books:

1. A Foundation Course in Human Values and Profession Ethics (Text Book andTeachers' Manual), R. R. Gaur, R. Asthana, G. P. Bagaria (2010), Excel Books,NewDelhi.
2. AvartanshcelArthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak,India.
3. An Appeal by the Dalai Lama to the World: Ethics Are More Important ThanReligion , Dalai Lama XIV,2015.
4. Economy of Permanence – (a quest for social order based on non-violence), J. C.Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India.
5. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & HarperCollins,USA.
6. Human Society, Kingsley Davis,1949.
7. Hind Swaraj or, Indian home rule Mohandas K. Gandhi, 1909.
8. Integral Humanism, Deendayal Upadhyaya,1965.
9. LohiyaKeVichar, Lok Bharti ,RammanoharLohiya,2008.
10. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak,India.
11. ManaviyaSanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India
12. SamadhanatmakBhautikvad, A. Nagraj, Divya Path Sansthan, Amarkantak,India
13. Small Is Beautiful: A Study of Economics as if People Mattered, E. F. Schumacher,1973, Blond & Briggs,UK.
14. SlowisBeautiful,CecileAndrews(http://www.newsociety.com/Books/S/Slow-is-Beautiful)
15. Sociology Themes and Perspectives, Harper Collins; EIGHT edition (2014), MartinHolborn and Peter Langley,1980.
16. Samagrakranti: Jaya Prakash Narayan's philosophy of social change, SiddharthPublications Renu Sinha,1996.
17. Science & Humanism – towards a unified worldview, P. L. Dhar & R. R. Gaur(1990), Commonwealth Publishers, NewDelhi
18. VyavaharvadiSamajshastra, A. Nagraj, Divya Path Sansthan, Amarkantak,India.
19. VyavahatmakJanvad, A. Nagraj, Divya Path Sansthan, Amarkantak,India.
20. The Communist Manifesto, Karl Marx,1848.
21. Toward a True Kinship of Faiths: How the World's Religions Can ComeTogether Dalai Lama XIV,2011.

DEPARTMENTAL ELECTIVE-3

POWER PLANT ENGINEERING

L T P
3 0 0

MEE 801

Course Objectives:

1. Describe sources of energy and types of powerplants
2. Analyze different types of steam cycles and estimate efficiencies in a steam powerplant
3. Describe basic working principles of gas turbine and diesel engine power plants. Definethe performance characteristics and components of such powerplants
4. List the principal components and types of nuclearreactors.
5. Evaluate cycle efficiency and performance of a gas cooled reactor powerplant
6. Classify different types of coupled vapor cycles and list the advantages of combinedcycles powerplant

UNIT-I

Introduction

Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. **3(L)**

Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of powerplantunit. **2(L)**

Power plant economics andselection

Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.**3(L)**

UNIT-II

Steam power plant

General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating , flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency,Site selection of a steam power plant.**8(L)**

UNIT-III

Diesel power plant

General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, Lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.**3(L)**

Gas turbine power plant

Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbinepowerplant. **5(L)**

UNIT-IV

Nuclear power plant

Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. **3(L)**

Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units. operation and maintenance, hydro systems, interconnectedsystems.**4(L)**

Non Conventional Power Plants

Introduction to non-conventional power plants (Solar, wind, geothermal, tidal) etc.**2(L)**

UNIT-V

Electrical system

Generators and generator cooling, transformers and their cooling, bus bar, etc.**2(L)**

Instrumentation

Purpose, classification, selection and application, recorders and their use, listing of various controlrooms. **3(L)**

Pollution

Pollution due to power generation**2(L)**

Course Outcomes:

On successful completion of the course, the student will be able to,

CO1. Summarize the layout and components in a power plant.

CO 2. Enumerate and classify the types of power plants available.

CO 3. Recognize the steam cycles on pressure - volume and temperature diagram.

CO 4. Outline the scenario of entire business of power plants along withperformance parameters, load curves and tariffcalculations.

CO 5. Relate and couple the different thermodynamic cycles to improve efficiency and to reduce pollution.

CO 6. Extend their knowledge to power plant economics and environmental hazards

Books and References:

1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt.Ltd.
2. Power Plant Engineering by Hedge, PearsonIndia.
3. Power Plant Technology, by Wakil, McGrawHill.
4. Power Plant Engineering by P.K. Nag, Tata McGrawHill.
5. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, CentralPub.House.
6. Power Plant Engineering by Gupta, PHIIndia.
7. El Wakil M.M., Power Plant Technology, Tata McGraw Hill,2010.
8. Power Plant Engineering. Mahesh Verma, Metropolitan Book Company Pvt.Ltd.

ADVANCED WELDING TECHNOLOGY

L-T-P
3-0-0
MEE 802

Course Objectives:

1. To understand the working principle, advantages, disadvantages of elctroslag, electrogas welding, thermit welding.
2. The student gains information on different solid-state weldingprocesses.
3. To understand the working principle, weld characteristics and process parameters of high energy beamwelding.
4. To understand the process of thermal cutting of materials, brazing andsoldering.
5. To understand the concept about underwater welding, welding in space and welding metallurgy.

UNIT-I:

Introduction: Welding as compared with other fabrication processes, Importance and application of welding, classification of welding processes, Health & safety measures in welding.

Welding Power Sources: Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators.

Physics of Welding Arc: Welding arc, arc initiation, voltage distribution along the arc, arc characteristics, arc efficiency, heat generation at cathode and anode, Effect of shielding gas on arc, isotherms of arcs and arc blow.

Metal Transfer: Mechanism and types of metal transfer in various arc welding processes.**9(L)**

UNIT-II:

Welding Processes:

Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electro gas and Electroslag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwavewelding.**8(L)**

UNIT-III:

Heat Flow Welding:

Calculation of peak temperature; Width of Heat Affected Zone (HAZ);cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.**8(L)**

UNIT-IV:

Repair & Maintenance Welding:

Hardfacing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Weldability: Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium. Micro & Macro structures inwelding.**8(L)**

UNIT-V:

Weld Design:

Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.7**(L)**

Course Outcomes: On completion of the course, student should be able to;

CO1: Differentiate the mechanism, working principle and process characteristics of electroslag, electro gas welding and thermit welding.

CO2:know the working principle, process characteristics, of friction welding, friction stir welding, ultrasonic welding, adhesive boning, explosion welding and diffusion bonding.

CO3: Describe the mechanism, working principle and process characteristics of high energy beam welding.

CO4: Differentiate between soldering and brazing, their techniques, advantages and limitations, applications. And also decide best cutting techniques for a particular application and their limitations.

CO5: Describe working principle and process characteristics of underwater welding processes, welding in space. And weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies.

Books and References:

1. Welding and Welding Technology, by- Richard L. Little, McGraw HillEducation.
2. Welding Principals and Practices, by- Edwars R. Bohnart, McGraw HillEducation.
3. Welding Engineering and Technology, by- R. S. Parmar, KhannaPublishsers.
4. Welding Technology Fundamentals by William. A.Bowditch.
5. Welding Technology by N KSrinivasan.
6. Welding Engineering and Technology by R SParmar.
7. Welding Handbooks (Vol. I &II).

NON-DESTRUCTIVE TESTING

L-T-P
3-0-0

MEE 803

Course Objective: To impart knowledge in various methods of Non Destructive Testing. Overview the concepts, principles, and methods employed for NDT of structures and materials.

Unit-I:

Introduction:

Scope and advantages of NDT, Comparison of NDT with Destructive Testing, some common NDT methods used since ages, Terminology, Flaws and Defects, Visual inspection, Equipment used for visual inspection. Ringing test, chalk test (oil whitening test). Uses of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection.8**(L)**

Unit-II:

Tests:
Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques. Testsstations, Advantages, types of penetrants and developers, Zyglo test, Illustrative examples and interpretation of defects.
Magnetic particle Inspection – scope and working principle, Ferro Magnetic and Nonferromagneticmaterials, equipment & testing. Advantages, limitations Interpretation of results, DC & AC magnetization, Skin Effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, Applications.**9(L)**

Unit-III:
Radiographic methods:
Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering), Pair production, Beam geometry and Scattering factor.
X-ray radiography: principle, equipment & methodology, applications, types of radiations and limitations. γ-ray radiography – principle, equipment., source of radioactive materials &technique, advantages of γ-ray radiography over X-ray radiography Precautions against radiation hazards. Case Study - castingandforging. **9(L)**

Unit-IV:
Ultrasonic testing methods:
Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Case Study – Ultrasonography of human body.**8(L)**

Unit-V:
Special NDT Techniques:
Eddy Current Inspection:
Principle, Methods, Equipment for ECT, Techniques, Sensitivity, advanced ECT methods. Application, scope and limitations, types of Probes and Case Studies. Introduction to Holography, Thermography and Acoustic emission Testing. **6(L)**

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

CO1	Understand the basic principles , techniques, equipment, applications and limitations of various NDT methods
CO2	Understand various NDT methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current
CO3	Understand the applications and limitations of NDT methods and techniques and codes
CO4	Understand how to select of appropriate NDT methods.
CO5	aware the developments and future trends in NDT

Books and References:
1. Non-Destructive Testing and Evaluation of Materials, by- Prasad, McGraw HillEducation.

2. Practical Non-destructive Testing, by- Baldev Raj, T. Jayakumar,M.
Thavasimuthu, Woodhead Publishing.
3. Non-Destructive Testing Techniques, by- Ravi Prakash, New AgeInternational.
4. Nondestructive Testing Handbook, by Robert C. McMaster, American Society for Nondestructive.
5. Introduction to Nondestructive Testing: A Training Guide, by- Paul E. Mix, wiley.
6. Electrical and Magnetic Methods of Non-destructive Testing, by- J. Blitz,springer.
7. Practical non destructive testing by Raj,Baldev.
8. Basics of Non-Destructive Testing, by Lari& Kumar, KATSONBooks.

Production Planning and Control

L-T-P
3-0-0
MEE 804

UNIT I INTRODUCTION

Objectives and benefits of planning and control, Functions of production control, Types of production, job- batch and continuous, Product development and design, Marketing aspect, Functional aspects, Operational aspect, Durability and dependability aspect aesthetic aspect.

UNIT II WORK STUDY

Method study, basic procedure, Selection, Recording of process, Critical analysis, Development - Implementation - Micro motion and memo motion study,

Work measurement - Techniques of work measurement, Time study, Production study, Work sampling, Synthesis from standard data, Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING

Product planning, Extending the original product information,Valueanalysis,Problems in lack of product planning, Process planning and routing, Pre requisite information needed for process planning, Steps in process planning, Quantity determination in batch production, Machine capacity, balancing, Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING

Production Control Systems, Loading and scheduling, Master Scheduling, Scheduling rules, Gantt charts, Basic scheduling problems,

Line of balance, Flow production scheduling, Batch production scheduling,

UNIT V PRODUCTION SEQUENCING

Product sequencing – Production Control systems-Periodic batch control-Material requirement planning, Kanban, Dispatching, Progress reporting and expediting, Manufacturing lead time,

Profit consideration- Standardization, Simplification & specialization, Break even analysis-Economics of a new design.

Course outcomes:

After learning the course the students should be able to:

CO 1	Analyze air-conditioning processes using the principles of psychrometry.
CO 2	Evaluate cooling and heating loads in an air-conditioning system.

CO 3	Analyze thermal distribution technique through heat exchangers, AC and its various types and advantages
CO 4	Analyze the optimum method of designing parts of turbomachinery
CO 5	Understand and solve the optimization problem for single variable and multivariable using the classical optimization technique.

Books and References:

1. Thermal Environment Engg. by Kuhen, Ramsey&Thelked.
2. Refrigeration & Air Conditioning - By C.P. Arora, McGrawHill
3. Refrigeration & Air Conditioning - By Manohar Prasad, NewAge
4. Heating, Ventilating and Air Conditioning - By Mc Quistion, Parker&Spitler
5. Refrigeration & Air Conditioning Data Book – Manohar Prasad, NewAge
6. ASHRAE Hand Book ofFundamentals-ASHRAE
7. Refrigeration & Air Conditioning-Stoecker& Jones, Mc GrawHill
8. Design of High Efficiency Turbomachinery and Gas Turbine by Wilsonm and Korakianitis, PHI,India
9. Turbines compressors and Fans by Yahaya, Mc GrawHill
10. Heat Transfer Equipment Design by Shah, CRCPress
11. Thermal System Design and Optimization by Balaji, Anc Books PvtLtd

DEPARTMENTAL ELECTIVE-4

ADDITIVE MANUFACTURING

L-T-P
3-0-0

MEE 805

Course Objectives: This course enables the students:

1. To learn the basic principle of additivemanufacturing.
2. To understand importance of additive manufacturing and itsapplications.
3. To acquire knowledge, techniques and skills to select relevant additive manufacturingprocess for the fabrication of theobject.
4. To explore the potential of additive manufacturing in different industrialdomains.

UNIT-I:

Introduction:

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines,

Direct and Indirect Processes: Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.**8(L)**

UNIT-II:

Development of Additive Manufacturing Technology:

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems. Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design ofAM.**8(L)**

UNIT-III:

Additive Manufacturing Processes:

Vat Photopolymerization, Materials, Reaction Rates, Photopolymerization Process Modelling, Scan Patterns, **Powder Bed Fusion Processes**:Material, Powder Fusion Mechanism, Process Parameters and Modelling, powder Handling,

Extrusion Based System: Basic principles, plotting and Path Control, Bio extrusion, Other Systems,

Material Jetting; Materials, Material Processing Fundamentals, Material Jetting Machines,

Binder Jetting: Materials, Process Variations, BJ Machines,

Sheet laminationProcesses: Materials, Ultrasonic Additive Manufacturing,

Directed Energy Deposition Processes: General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing- Structure-Properties Relationships,

Direct Write Technologies: Ink-Based DW, laser Transfer DW, Thermal Spray DW, Beam Deposition DW, Liquid Phase Direct Deposition, Hybrid Technologies.**10(L)**

UNIT-IV:

Design & Software Issues:

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AMbasedNewStrategies, Material Design and Quality Aspects for Additive Manufacturing;Material for AM,Engineering Design Rules for AM.**4(L)**

Software Issue for Additive Manufacturing: Introduction, Preparation of CAD Models: TheSTLfile,Problem with STL file, STL file Manipulation, Beyond the STL file, AdditionalSoftware to Assist AM.**4(L)**

UNIT-V:

Material Design & Quality Aspects:

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes,IntellectualProperty, Product Development, Commercialization, Trends and Future Directions inAdditiveManufacturing, Business Opportunities.**4(L)**

Applications:

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys,Medical,Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.**2(L)**

Course Outcomes: After the completion of this course, students will be:

CO1 Able to define the various process used in Additive Manufacturing/Rapid Prototyping

CO2 Able to analyse and select suitable process and materials used in Additive Manufacturing/Rapid Prototyping.

CO3 Able to identify, analyse and solve problems related to Additive Manufacturing/Rapid Prototyping.

CO4 Able to apply knowledge of additive manufacturing for various real-life problems

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- IanGibson, D Savid W. Rosen, Brent Stucker,Springer.
2. Additive Manufacturing, by- Amit Bandyopadhyay, Susmita Bose, CRCPress.
3. Rapid Prototyping: Principles and Applications, by - Chee Kai Chua, Kah Fai Leong, Chu SingLim.
4. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct DigitalManufacturingby Ian Gibson and DavidRosen.
5. Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, MedicalImplants, and Custom Jewelry (Springer Series in Materials Science) by John OMilewski.
6. Additive Manufacturing: Advanced Manufacturing Technology in 3d Print DepositbySabrieSoloman.
7. Advances in 3D Printing and Additive Manufacturing Technologies by David Ian WimpennyandPulak MPandey.
8. Understanding Additive Manufacturing, by- Andreas Gebhardt,Hanser.

UNCONVENTONAL MACHINING PROCESSES

L-T-P3-0-0
MEE 806

Course Objectives:

1. Understand the need and importance of non-traditional machining methods andprocess selection.
2. Gain the knowledge to remove material by thermal evaporation, mechanicalenergy process.
3. Apply the knowledge to remove material by chemical and electro chemicalmethods.
4. Analyze various material removal applications by unconventional machiningprocess.

UNIT I:
INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES
Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT II:
THERMAL AND ELECTRICAL ENERGY BASED PROCESSES
Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing — Applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques –Applications.

UNIT III:
CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES
Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process Parameters- ECG and ECH - Applications.

UNIT IV:
ADVANCED NANO FINISHING PROCESSES
Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT V:

RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

COURSE OUTCOMES (CO's)

CO 1. Compare non-traditional machining, classification, material applications in material removal process

CO 2. Summarize the principle and processes of abrasive jet machining.

CO 3. Understand the principles, processes and applications of thermal metal removal processes.

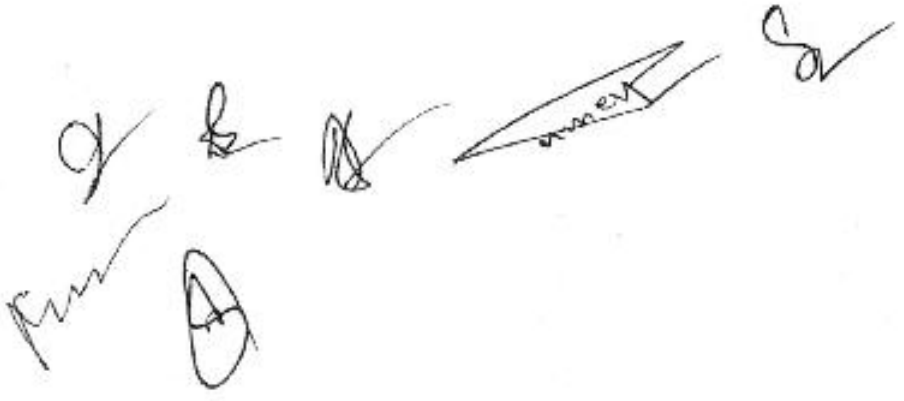
CO 4. Identify the principles, processes and applications of EBM.

CO 5. Understand the principles, processes and applications of Plasma Machining.

Text Books: 1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel – Gawad El-Hafy/CRC Press-2016.

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/



THEORY OF ELASTICITY AND PLASTICITY

L-T-P
3-0-0

MEE 807

Course Objective:

1. To impart knowledge of Principal stresses and strains.
2. To develop analytical skills of solving problems using plain stress and plainstrain.
3. To impart knowledge of engineering application ofplasticity.

UNIT-I

Elasticity: Analysis of stress and strain, Definition of stress and strain at a point, Equilibrium and compatibility equations, Transformation of stress and strain at a point Principal stresses and strains: Stress and strain invariants, hydrostatic and deviator stress strains.

UNIT-II

Plane stress and plane strain: - Simple two dimensional problems in Cartesian and polar co-ordinates, Airy's stress function in rectangular and polar coordinates.

UNIT-III

Stress-strain relations for linearly elastic solids: Generalized Hooke's law. Solution of axi-symmetric problems, stress concentration due to presence of a circular hole, Elementary problems of elasticity in three dimensions.

UNIT-IV

Torsion: St.Venant's approach-Prandtl's approach – Membrane analogy - Torsion of thin walled open and closed sections.

UNIT-V

Plasticity: Physical Assumptions – Yield criteria - Tresca and VonMises criterion of yielding, plastic stress strain relationship, Elastic plastic problems in bending. Some engineering applications of elasticity and plasticity.

Course Outcomes:

1. The students shall be able to demonstrate the application of plane stress and plane strain in a givensituation.
2. The student will demonstrate the ability to analyze the structure usingplasticity.
3. To impart the knowledge of stress-strain relations for linearly elastic solids, andTorsion.

TEXT BOOKS

1. Timoshenko, S. and Goodier J.N. "Theory of Elasticity", 2nd Edition, McGraw Hill Book Co, 2001.
2. Sadhu Singh, "Theory of Elasticity", 3rd Edition, Khanna Publishers,2003.

REFERENCES:

1. Chen W.F. and Han D.J. "Plasticity for structural Engineers", 1st Edition,. Springer-Verlag, 2000.
2. Irving H.Shames and James,M.Pitarresi. "Introduction to Solid Mechanics", 4th Edition,

Prentice Hall of India Pvt. Ltd.,2000.

PLANT LAYOUT AND MATERIAL HANDELING

L-T-P
3-0-0
MEE 808

Course Objective:

1. Get the basics of process layout & product layout.
2. Get the idea about the material handling systems.
3. Learn about the different types material handling methods , paths equipmentsandfunctions.

UNIT -I

Introduction: Criteria, Strategies/Tactics, Sustainability and Eco-Efficiency in Facility Design, Basic Planning,Alternative Machine Arrangements, Flow Lines, Location Models, Act/Building Details, Aislesand Security, Storage, Shipping and Receiving, Offices, Specialized Areas.**8(L)**

UNIT -II

Workstations, Unit Loads & Containers, Conveyors, Vehicles, Lifting Devices, WorkstationMaterial Handling, Ethics in Facility DesignFacilities design procedure and planning strategies, Production, activity and materials flowanalysis, Space requirements and personnel services design considerations.**8(L)**

UNIT -III

Layout construction techniques: systematic layout planning; activity relationship analysis, pairwise exchange, graph-based construction algorithmic.
Material Handling: Material handling principles; material handling equipment and materialhandling systems.**8(L)**

UNIT -IV

Computerized Layout and Analytical Methods: ALDEP, CORELAP, CRAFT, BLOCPLAN,etc.
Warehouse operations: function, storage operations.
Manufacturing operation: JIT, TQM, AM, CIM, SCM, Facility systems,
Quantitative models: Layout model, waiting line, AS/RS, simulation model, etc.**8(L)**

UNIT -V

Assessment and evaluation of layout alternatives Projects, Use Spiral software to practice plantlayout design, Apply mathematical and engineering techniques such as systematic layoutplanning approach, quantitative model, cost estimate to solve practical facility layout problem.
8(L)

Course Outcomes:

CO1. Able to get the basics of process layout & product layout
CO2. Able to get the idea about the material handling systems
CO3. Able to know about the different types material handling methods, paths equipments and

functions.

Books and References:

1. Plant Layout and Material Handling, by- James M. Apple, John Wiley &Sons.
2. Plant Layout and Material Handling, by- Fred E. Meyers, PrenticeHall.
3. Facility Layout and Location: An Analytical Approach, by Richard L, Francis, PearsonIndia.
4. Plant Layout and Material Handling, by- B. K. Aggarwal, Jain Brothers.
5. Plant Layout and Material Handling, by- S. C. Sharma, JainBrothers.
6. Materials Handling Handbook, by- Raymond A. Kulwiec, John Wiley &Sons.
7. Plant Design and Economics, by- Peters, McGraw HillEducation.
8. Purchasing and Material Management, by- Gopalakrishnan, McGraw HillEducation.

पुराना

INSTITUTE OF ENGINEERING & TECHNOLOGY
Dr. RAMMANOHAR LOHIA AVADH UNIVERSITY
FAIZABAD

Syllabus
For

M.Tech.

Mechanical Engineering (Full Time)

(Effective from the Session: 2020-21)

Study and Evaluation Scheme M. Tech. in Mechanical Engineering

(Effective from Session 2020-21)

First Year, Semester-I

S.No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme				Subject Total
							Theory			Practical	
			L	T	P		CT	TA	ESE	TA	
1	MTME 101	Simulation, Modelling & Analysis	3	0	0	3	20	10	70		100
2	MTME 102	Turbo Machines	3	0	0	3	20	10	70		100
3	MTME 01?	Departmental Elective-I	3	0	0	3	20	10	70		100
4	MTME 02?	Departmental Elective-II	3	0	0	3	20	10	70		100
5		Research Process & Methodology	3	0	0	3	20	10	70		100
6	MTME 151	Simulation, Modelling & Analysis Lab	- -	- -	3	2	--	--	--	50	50
7	MTME 152	Turbo Machines Lab	- -	- -	2	1	--	--	--	50	50
		Total				18					**600**

Departmental Elective–I	MTME 011	CAD/CAM
	MTME 012	Advanced Heat & Mass Transfer
	MTME 013	Renewable Energy System
	MTME 014	Reliability, Maintenance Management & Safety

Departmental Elective–II	MTME 021	Advanced Mechanical Vibrations
	MTME 022	Fracture Mechanics
	MTTE 023	Advanced I.C. Engines
	MTME 024	Optimization Techniques & Design of Experiments

First Year, Semester-II

S.No	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme				Subject Total
							Theory			Practical	
			L	T	P		CT	TA	ESE	TA	
1	MTME 201	Computer Integrated Manufacturing (CIM)	3	0	0	3	20	10	70		100
2	MTME 202	Modern manufacturing Process	3	0	0	3	20	10	70		100
3	MTME 03?	Departmental Elective-III	3	0	0	3	20	10	70		100
4	MTME 04?	Departmental Elective-IV	3	0	0	3	20	10	70		100
5	MTME 05?	Elective -V	3	0	0	3	20	10	70		100
6	MTME 251	Computer Integrated Manufacturing (CIM) Lab	- -	- -	3	2	--	--	--	50	50
7	MTME 252	Seminar-I	- -	- -	- -	1	--	--	--	50	50
		Total				18					**600**

Departmental Elective – III	MTME 031	Advanced Finite Element Analysis
	MTME 032	Industrial Automation And Robotics
	MTME 033	Operation Research
	MTTE 202	Computational Fluid Dynamics

Departmental Elective – IV	MTME 041	Total Quality Management
	MTME 042	Advanced Welding Technology
	MTME 043	Advanced Mechanical Design
	MTME 044	Advanced Engineering Materials

Elective – V	MTME 051	Flexible Manufacturing System
	MTME 052	Advnaced Material Characterization Techniques
	MTME 053	Additive Manufacturing and Tooling
	MTME 054	Machine Tool Engineering

Second Year, Semester-III

S.No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1	MTME 352	Seminar-II	0	0	6	3	--	--	--	100	--	100
2	MTME 351	Dissertation	0	0	30	15	--	--	--	250	250	500
		Total				18						**600**

Second Year, Semester-IV

S.No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1	MTME 451	Dissertation (Final)	0	0	36	18	--	--	--	300	300	600
		Total				18						600

SIMULATION, MODELLING & ANALYSIS

MTME 101

Course Learning Objective:

1. Define the basics of simulation modeling and replicating the practical situations in organizations
2. Generate random numbers and random variates using different techniques.
3. Develop simulation model using heuristic methods.
4. Analysis of Simulation models using input analyzer, and output analyzer
5. Explain Verification and Validation of simulation model.

Introduction: Simulation: a tool, advantages and disadvantages of simulation, areas of application, Systems and system environment, components of a system, discrete and continuous systems, discrete event system simulation.
General Principles: Concepts in discrete event simulation, time advance algorithm, manual simulation Using event scheduling, basis properties and operations.

Models In Simulation: Terminology and concepts, statistical models: queuing systems; inventory Systems; reliability and maintainability, limited data, discrete distributions: Bernoulli distribution; Binomial distribution; Geometric distribution, continuous distribution: Uniform distribution; Exponential distribution; Gamma distribution; Normal distribution; Weibull distribution; Triangular Distribution; Lognormal distribution, poisson process,

Queueing Models: Characteristics of queuing systems, the calling population, system capacity, arrival process, service mechanism, queuing notations, long run measures of performance of queuing systems, server utilization in G/G/1/∞/∞ queues, server utilization in G/G/C/∞/∞ queues, server utilization and system performance, costs in queuing problems, Larkovian models.

Random Number Generation: Properties of random numbers, Pseudo random numbers, techniques of generating random numbers, tests of random numbers.

Random Variate Generation: Inverse transform technique, Direct transformation for the Normal and Lognormal distribution, Convolution Method, Acceptance rejection technique.

Input Modelling And Validation: Steps in the development of model, data collection, Distribution identification, Parameter estimation, Goodness of Fit Tests, selecting input models without data, verification and validation of simulation models.

Course Outcomes: After the successful completion of the course, the students will be able to:
CO1- Describe the role of important elements of discrete event simulation and modeling paradigm.
CO2- Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
CO3- Develop skills to apply simulation software to construct and execute goal-driven system models.
CO4- Interpret the model and apply the results to resolve critical issues in a real world environment.

Books:

1. Simulation Modelling and Analysis by Law and Kelton, Mc Graw Hill.
2. Simulation Model Design& execution by Fishwich, Prentice Hall.
3. Discrete event system simulation by Banks, Carson, Nelson and Nicol.

SIMULATION, MODELLING & ANALYSIS LAB

MTME 151

1. Study of simulation software Like ARENA , MATLAB.
2. Simulation of translational and rotational mechanical systems
3. Simulation of Queuing systems
4. Simulation of Manufacturing System
5. Generation of Random number
6. Modeling and Analysis of Dynamic Systems
7. Simulation mass spring damper system
8. Simulation of hydraulic and pneumatic systems.
9. Simulation of Job shop with material handling and Flexible manufacturing systems
10. Simulation of Service Operations

TURBO MACHINES

MTME 102

Course Learning Objective:

1. To learn classification of turbomachines
2. To calculate energy transfer through a turbomachine
3. To understand energy transfer and losses in centrifugal compressors, axial fans and steam turbines

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

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. Leakage losses, Thermodynamic analysis of steam turbines.

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

Centrifugal compressor: Types, Velocity triangles and efficiencies, Thermodynamic analysis; stage pressure rise ; Degree of reaction ; stage loading ; Determination of Stage Efficiency, Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

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, Axial Flow Compressor Performance, Surge and Stall in Compressor and the Remedies, performance.
Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

AXIAL FLOW GAS TURBINES: Introduction, Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Determination of Turbine Stage Efficiency, Stress in blades, Blade assembling, Material and cooling of blades, Performances.

Course Outcomes: At the end of the course, the student will be able to:
CO1- analyze energy transfer through graphical and analytical methods in turbo machines
CO2- design different kinds of turbomachines.
CO3- Evaluate the performance of turbo machine components.
CO4- Analyze power plant and propulsion cycles.

REFERENCES:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons
3. Element of Gas Dynamics/Yahya/TMH
4. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/Newyork
5. Turbines, Pumps, Compressors/Yahya/TMH
6. Practice on Turbo Machines/ G.Gopal Krishnan & D.Prithviraj/ Sci Tech Publishers, Chennai
7. Theory and practice of Steam Turbines/ WJ Kearton /ELBS Pitman/London

Turbo Machine Lab

MTME 152

List of Experiments:

1) To Study downstream wake profile of a turbine cascade at mid span on Low speed wind tunnel.
2) To Study downstream wake profile of a compressor cascade at mid span on Low speed wind tunnel.
3) Study on performance of Centrifugal blower with forward swept blades.
4) Study on performance of Centrifugal blower with backward swept blades.
5) Study on performance of Centrifugal blower with radial blades.
6) Unsteady state Heat Transfer.
7) Thermal Conductivity of Liquid.
8) Experiments on Convergent Divergent Subsonic Nozzle.

DEPARTMENTAL ELECTIVE-I

CAD/CAM

MTME 011

Course Learning Objective:

The general objectives of the course are to enable the students to

1. Understand the basic fundamentals of computer aided design and manufacturing.
2. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc.
3. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication.
4. To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control.
5. To learn the overall configuration and elements of computer integrated manufacturing systems.

Mathematical Elements, CAD, Solid modeling methods, Database structures for CAD, CSG formulation, B-rep and wire frame methods, Intersection surface generation methods, Boundary file generation methods, Feature based modeling systems, Surface modeling, B- splines, Coons and Bezier surfaces, NURBS and surface patches, fitting surfaces for arbitrary digested points, Offset surfaces, Fillet surfaces, Sewn surfaces.

Features recognition from the databases, IGES, STEP, PDES, and DXF data exchange formats, Graphic standards for CAD/CAM such as GKS, PHIGS and VDI.

Concurrent engineering integration of manufacturing principles and analytical principles in design, Manufacturing information generation from CAD data, Planar sectioning, Penalty functions, cavity milling, Optimization of cutter path, Effect of tool profile geometry, Methods for multi-axis machining, Methods for software design for CAD/CAM system, use of software libraries, Development of software package for a specific problem as part of course using software libraries.

Introduction to automation, CAM/CIM, Part programming, Interpolator & Control.

Course Outcomes: At the end of the course, the student will be able to:
CO1- Understand geometric transformation techniques in CAD.
CO2- Develop mathematical models to represent curves and surfaces.
CO3- Model engineering components using solid modeling techniques.
CO4- Understand the elements of an automated manufacturing environment.

Books:

1. Computer Graphics D Hearn & M P Baker Prentice Hall
2. CAD/CAM Theory and Practice Ibrahim Zeid & R Sivasubramanian Tata McGraw-Hill
3. Mathematical Elements for Comp. Graphics D F Rogers and J A Adams McGraw-Hill International
4. Computer Aided Engineering & Design Jim Browne New ATC International
5. The Engineering Database D.N. Chorafas and S.J. Legg Butterworths
6. Principles of CAD J Rooney &P Steadman Longman Higher Education
7. CAD/CAM H P Groover and E W Zimmers Prentice Hall

ADVANCED HEAT & MASS TRANSFER

MTME 012

Course Learning Objective:

1. To present fundamentals of momentum, heat and mass transfer
2. To introduce general conservation equation for transport phenomena.
3. To introduce analogy between momentum, heat and mass transfer.

Review: Reviews of basic laws of Conduction, Convection and Radiation

Conduction: One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, Local heat source in non-adiabatic plate, Thermocouple conduction error, Extended Surfaces-Review, Optimum fin of rectangular profile, straight fins of triangular and parabolic profiles, Optimum profile, Circumferential fin of rectangular profile, spines, design considerations. 2D steady state conduction, semi-infinite and finite flat plates, Temperature fields in finite cylinders and in infinite semi -cylinders, spherical shells, Graphical method, relaxation technique. Unsteady state conduction, Sudden changes in the surface temperatures of infinite plates, cylinders and spheres using Grocber's and Heisler charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation: Review of radiation principles, Diffuse surfaces and the Lambert's cosine law. Radiation through non-absorbing media, Hottel's method of successive reflections, Gebhart's unified method, Poljak's method. Radiation through absorbing media, Logarithmic decrement of radiation, Apparent absorptive of simple shaped gas bodies, Net heat exchange between surfaces separated by absorbing medium, Radiation of luminous gas flames.

Convection: Heat transfer in laminar flow, free convection between parallel plates, Forced internal flow through circular tubes, Fully developed flow, Velocity and thermal entry length, solutions with constant wall temperature and with constant heat flux, Forced external flow over a flat plate, two-dimensional velocity and temperature boundary layer equations, Karman Pohlhousen approximate integral method. Heat transfer in turbulent flow, Eddy heat diffusivity, Reynold's analogy between skin friction and heat transfer, Prandtl-Taylor, Von Karman and Martineli's analogies, Turbulent flow through circular tubes.

Course Outcomes: At the end of the course, the student will be able to:
CO1- Provide a thorough understanding of applications of classical heat transfer to practical problems. Applications include heat pipe and heat exchanger, etc.
CO2- Introduce the analytical and numerical solutions for heat transfer analysis.
CO3- Provide limited design experiences for systems requiring significant consideration of heat transfer.

REFERENCES:

1. Principals of Heat Transfer/Frank Kreith/Cengage Learning
2. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012
3. Heat Transfer/RK Rajput/S.Chand
4. Introduction to Heat Transfer/SK Som/PHI
5. Engineering Heat & Mass Transfer/Mahesh Rathore/Lakshmi Publications
6. Heat Transfer / Necati Ozisik / TMH
7. Heat Transfer / Nellis & Klein / Cambridge University Press / 2012.
8. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
9. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai

RENEWABLE ENERGY SYSTEM

MTME 013

Course Learning Objective:

1. You have profound knowledge in a special field such as solar energy, storage, smart grid.
2. You are able to use laboratories and emulators of renewable energy systems to analyze relevant issues.
3. You should be used to working in interdisciplinary groups.

Introduction: Energy and Development; Energy demand and availability; Energy crisis; Conventional and Nonconventional energy; Renewable and Non-renewable energy resources; Environmental impacts of conventional energy usage; Basic concepts of heat and fluid flow useful for energy systems.

Solar Energy Systems: Solar radiations data; Solar energy collection, Storage and utilization; Solar water heating; air heating; Power generation; Refrigeration and Air-conditioning; Solar Energy system Economics.

Micro and Small Hydro Energy Systems: Resource assessment of micro and small hydro power; Micro, mini and small hydro power systems; Economics; Pump and turbine; Special engines for low heads; Velocity head turbines; Hydrams; Water mill; Tidal power.

Bio mass Energy Systems: Availability of bio mass-agro, forest, animal, municipal and other residues; Bio mass
conversion technologies; Cooking fuels; Biogas; producer gas; Power alcohol from biomass; Power generation; Internal engine modifications and performance; system economics.

Wind Energy Systems: Wind data; Horizontal and vertical axis wind mills; Wind farms; Economics of wind energy.

Integrated Energy Systems: Concept of integration of conventional and non-conventional energy resources and systems; Integrated energy system design and economics.

Course Outcomes: At the end of the course, the student will be able to:
CO1 - Ability to recognize the need of renewable energy technologies and their role in the Greece and world energy demand.
CO2 - Knowledge of the operating principles of renewable energy production from various renewable sources
CO3 - Ability to compare the advantages and disadvantages of various renewable energy technologies and propose the best possible energy conversion system for a particular location.

Books:
1. Energy Efficient Buildings in India Mili Majumdar Tata Energy Research Institute
2. Understanding Renewable Energy Systems Volker Quaschning -
3. Renewable Energy Systems Simmoes Marcelo Godoy CRC Press
4. Renewable Energy Resources John Twidell Taylor and Francis
5. Renewable Energy Sources and Their Environmental Impact Abbasi & Abbasi Prentice Hall of India

RELIABILITY, MAINTENANCE MANAGEMENT & SAFETY

MTME 014

Course Learning Objective:

1. Understand the main forms of maintenance and their application.
2. To enhance, through modifications, extensions, or new low-cost items, the productivity of existing equipment or production capacity
3. To advise on the acquisition, installation and operation of machinery;

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Optimization, Reliability – Cost trade off, Prediction and analysis, Problems.

Maintainability, Availability & Failure Analysis: Maintainability & Availability – Introduction, formulae, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability, simple problems, Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Maintenance Systems: Fixed time maintenance, Condition based maintenance, Operate to failure, Opportunity
maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terrotechnology.

Condition Monitoring: Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant
monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic system, Machine diagnostics - Objectives, Monitoring strategies, Examples of monitoring and diagnosis, Control structure for machine diagnosis.

Safety Aspects: Importance of safety, Factors affecting safety, Safety aspects of site and plant, Hazards of commercial chemical reaction and operation, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety.

Course Outcomes: At the end of the course, the student will be able to:
CO1 - Ability to apply knowledge of mathematics, statistics, basic sciences, and engineering to work professionally in industrial systems
CO2 - Ability to identify design problems, to design a system, component or process to meet desired needs that may include issues related to manufacturability, reliability, quality, environment, health and safety, ethics and society.

CO3 - Ability to use the techniques, skills and modern engineering tools necessary for engineering practice

Books:

1. Concepts in Reliability Engineering L.S. Srinath Affiliated East West Press
2. Maintainability and Reliability Handbook Editors: Ireson W.A. and C.F. Coombs McGraw Hill Inc.
3. Failure Diagnosis and Performance Monitoring L.F. Pau Marcel Dekker
4. Industrial Maintenance Management S.K. Srivastava S. Chand & Co Ltd.
5. Management of Industrial Maintenance Kelly and M.J. Harris Butterworth and Co.
6. Maintenance, Replacement and Reliability A.K.S. Jardine Pitman Publishing
7. Engineering Maintainability: How to Design for Reliability and Easy Maintenance B.S. Dhillon Prentice Hall of India

DEPARTMENTAL ELECTIVE-II

ADVANCED MECHANICAL VIBRATIONS

MTME 021

Course Learning Objective:

1. Teaching the advanced knowledge on mechanical vibrations.
2. Teaching the obtaining equation of motion
3. Teaching generalized coordinates and generalized forces
4. Teaching Eigenvalue problem and system response
5. Determining Natural Frequencies and Mode shapes
6. Determining forced response

Introduction: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations

Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation.

Multi-degree Freedom systems: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency- Rayleigh's, Dunkerely, Stodola and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems.

Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars

Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum

Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations.

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

CO1 - Ability to define, formulate and solve advanced problems of mechanical vibrations
CO2 - Able to provide information about determining Natural Frequencies and Mode shapes
CO3 - Able to provide information about determining forced response

Books:

1. Theory and practice of Mechanical Vibrations J.S. Rao and K. Gupta New Age International
2. Mechanical Vibrations G.K. Groover Nem Chand & Brothers
3. Mechanical Vibration Practice V. Ramamurti Narosa Publications
4. Mechanical Vibrations V.P. Singh Dhanpat Rai & sons
5. Textbook of Mechanical Vibrations R.V. Dukkipati & J. Srinivas Prentice Hall of India

FRACTURE MECHANICS

MTME 022

Course Learning Objective:

1. To understand the theory and application of the finite element method for analyzing structural systems.
2. To learn Approximation theory for structural problems as the basis for finite element methods.
3. To learn formulations for a variety of elements in one, two, and three dimensions.
4. To understand modeling and analysis of structures using planar, solid, and plate elements.

Introduction and overview, Concepts of fracture mechanics and strength of materials, Elements of solid mechanics, Elasticity and plasticity, Incremental plasticity and deformation theory.

Elastic crack-tip fields, Basic concepts of linear elastic fracture mechanics, Griffth's theory, stress intensity factor, Energy release rate, Plastic zone and fracture toughness, path invariant integrals and numerical approach.

Plastic crack-tip fields, Mode-I fields and fracture criterion, Engineering approach to plastic fracture, J-integral approaches and numerical concepts, Tearing modulus, Time dependent fracture, non-linear aspects of fatigue crack growth, Theoretical models, Fatigue cracks in welds, standard tests and testing procedures.

Brittle fracture of welded structures, Notch toughness, weld cracks and joint restrains, Weld defects and service behaviour, Application of fracture mechanics concepts and limitations, Weld cracking tests and elimination of joint restraints, Residual stress and its interaction in fracture behaviour, Numerical approaches for estimation of fracture parameters.

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

CO1 - Predict material failure for any combination of applied stresses.
CO2 - Estimate failure conditions of a structure
CO3 - Determine the stress intensity factor for simple components of simple geometry
CO4 - Predict the likelihood of failure of a structure containing a defect

Books:

1. Fracture Mechanics: Fundamentals and Applications Anderson, T. L CRC Press
2. Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue Dowling, Norman E Dowling Prentice Hall
3. Advanced Fracture Mechanics Kanninen, Melvin F Popelar, Carl H Oxford University Press
4. Analytical Fracture Mechanics Unger, David J Dover Publications

ADVANCED I.C. ENGINES

MTTE 023

Course Learning Objective:

1. Engine operating parameters like fuel-air mixtures, temperature and cycles
2. Supercharging, turbo charging and flow through ports and valves
3. Combustion process in SI engine and CI engine and emissions formation during the combustion cycle and their treatment.
4. Metering and flow of charge in SI engines
5. Modern trends in IC engines

Introduction to Different types of IC Engine Systems.

Classification, Construction, Valve arrangements, Fuels, Properties of fuels, Rating of fuels, Alternative fuels, Fuel air cycle, Actual cycles, Combustion in SI engines, Combustion in CI engines, Effect of engine variables, Combustion chambers, Carburation and fuel injection, Knocking, Engine cooling, Friction and lubrication, Supercharging, Turbocharging, Boost control, Testing and performance, Pollution due to engines.

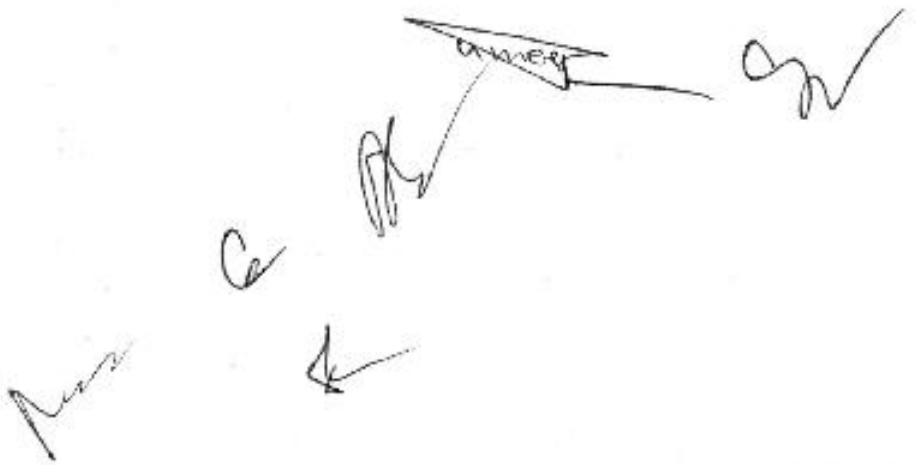
Design for SI and CI Engines.

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

CO1 - Design parameters like fuel-air mixtures and cycle analysis
CO2 - Gas exchange processes and motion of charge in the cylinder and its effects on combustion process in SI and CI engines and control the pollutant formation
CO3 - Flow in carburetor and Intake manifolds

Books:

1. Internal Combustion Engines: Applied Thermo sciences Ferguson Colin R John Wiley
2. Fundamentals of Internal Combustion Engines H.N. Gupta Prentice Hall
3. Internal Combustion Engines SK Agrawal New Age international
4. Engineering Fundamentals of the Internal Combustion Engine WW Pulkrabek Prentice Hall of India



OPTIMIZATION TECHNIQUES & DESIGN OF EXPERIMENTS

MTME 024

Course Learning Objective:

1. Understand the different optimization technique
2. Explain basic principles of design of experiments.
3. Develop factorial and fractional factorial designs for product and process optimization.
4. Design and conduct orthogonal array experiments for process improvement.

Single Variable Non-Linear Unconstrained Optimition: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

Multi Variable Non-Linear Unconstrained Optimization: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.

Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P **Dynamic Programming:** Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

Linear Programming: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. **Simulation**: Introduction – Types – Steps – application – inventory – queuing – thermal system.

Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

Stochastic Programming: Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

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

CO1 - Cast engineering minima/maxima problems into optimization framework.
CO2 - Learn efficient computational procedures to solve optimization problems.
CO3 - Ability to bring together and flexibly apply knowledge to characterise, analyse and solve a wide range of problems

Books:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin.
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia.

7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia.

MTCC 101 Research Process and Methodology

Course Learning Objective:

1. understand some basic concepts of research and its methodologies
2. identify appropriate research topics
3. select and define appropriate research problem and parameters
4. prepare a project proposal (to undertake a project)
5. organize and conduct research (advanced project) in a more appropriate manner
6. write a research report and thesis
7. write a research proposal (grants)

Unit 1: Introduction to Research and Problem Definition

Meaning, Objective and importance of research, Types of research, steps involved in research, defining research problem

Unit 2: Research Design

Research design, Methods of research design, research process and steps involved, Literature Survey

Unit 3: Data Collection

Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in research

Unit 4: Data Analysis and interpretation

Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), statistical inference, Interpretation of results

Unit 5: Technical Writing and reporting of research

Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc., Referencing and referencing styles, Research Journals, Indexing and citation of Journals, Intellectual property, Plagiarism

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

CO1 - Understanding of the basic framework of research process.
CO2 - Understanding of various research designs and techniques.
CO3 - Identify various sources of information for literature review and data collection.
CO4 - Understanding of the ethical dimensions of conducting applied research.

Text Books:

1. C. R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age International publishers, Third Edition.
2. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, SAGE, 2005
3. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
4. Creswell, John W. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 2013.

COMPUTER INTEGRATED MANUFACTURING (CIM)

MTME 201

Course Learning Objective:

1. Explain basic concepts of computer integrated manufacturing systems and interactions amongst its elements.
2. Develop and implement computer integrated manufacturing systems for various applications.
3. Analyze automation system to achieve optimum productivity.
4. Demonstrate computerized process planning.

Introduction to CNC Machine Tools: Development of CNC Technology-Principles and classification of CNC machines, Advantages & economic benefits, Types of control, CNC controllers, Characteristics, Interpolators, Applications, DNC concept.

CNC Programming: Co-ordinate System, Fundamentals of APT programming, Manual part programming-structure of part programme, G & M Codes, developing simple part programmes, Parametric programming, CAM packages for CNC machines-IDEAS, Uni graphics, Pro Engineer, CATIA, ESPIRIT, Master CAM etc., and use of standard controllers-FANUC, Heidenhain and Sinumeric control system.

Tooling for CNC Machines: Cutting tool materials, Carbide inserts classification; Qualified, semi-qualified and preset tooling, Cooling fed tooling system, Quick change tooling system, Tooling system for machining centre and turning center, tool holders, Tool assemblies, Tool magazines, ATC mechanisms, Tool management.

Robotics and Material Handling Systems: Introduction to robotic technology, and applications, Robot anatomy,
material handling function, Types of material handling equipment, Conveyer systems, Automated guided vehicle systems, Automated storage/retrieval systems, Work-in-process storage, Interfacing handling and storage with manufacturing.

Group Technology and Flexible Manufacturing System: group Technology-part families, Parts classification and coding, Production flow analysis, Machine Cell Design, Benefits of Group Technology, Flexible manufacturing systems- Introduction, FMS workstations, Computer control system, Planning for FMS, Applications and benefits.

Computer Integrated Manufacturing: Introduction, Evaluation of CIM, CIM hardware and software, Requirements of computer to be used in CIM system, Database requirements, Concurrent engineering-Principles, design and development environment, advance modeling techniques.

Course Outcomes: At the end of the course, the student will be able to:
CO1 - Describe various types of automation and production concepts.
CO2 - Distinguish various automated flow lines in high volume production systems.
CO3 - Analyze and Design appropriate automated assembly systems
CO4 - Apply Computer aided process planning, MRP and CNC part programming

Books:
1.Computer Numerical Control Machines P. Radahkrishnan New Central Book Agency
2.CNC Machines M.S. Schrawat and J.S. Narang Dhanpat Rai and Co.
3.CNC Programming Handbook Smid Peter Industrial Press Inc.
4. Automation, Production systems and Computer M.P. Groover, Prentice Hall of India Integrated Manufacturing
5. Computer Integrated Manufacturing Paul Ranky Prentice Hall of India

COMPUTER INTEGRATED MANUFACTURING LAB

MTME 251

1. 3D Modeling using CAD software.
2. CNC programming on turning.
3. CNC programming on milling.
4. Simulation of CNC programming on CAM Software
5. Study and demonstration on Robots.
6. Basic Robot Programming and Simulation.
7. Study of computer controlled business functions.
8. Study of interfacing requirements in CIMS.
9. Generation of any surface using any CAD software.
10. Design/ Thermal Analysis by CAD Software.

MODERN MANUFACTURING PROCESSES

MTME 202

Course Learning Objective:

1. Explain range of current industrial processes and practices used to manufacture products in high and low volumes. Focus in depth on a few selected processes.

2. Apply physics to the factors that control the rate of production and influence the quality, cost and flexibility of processes.
3. Explain the impact of manufacturing constraints on product design and process planning.
4. Demonstrate the working principle of various Modern Manufacturing methods
5. Develop new modern manufacturing methods by using hybrid combination

Advanced machining theory & practices - mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in orthogonal cutting; analysis of turning, drilling, and milling operations; mechanics of grinding; dynamometry; thermal aspects of machining; tool wear; economics of machining; processing of polymers, ceramics, and composites;

Advanced machining processes - introduction of USM, AJM, ECM, EDM, LBM, and EBM;

Advanced forming processes - electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, contour roll forming; Advanced welding processes - EBW, LBW, USW;

Unconventional and special Welding Processes and Automation: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Laser beam welding, Automation in welding, Welding robots, Overview of automation of welding in aerospace, Nuclear, Surface transport vehicles and under water welding.

Rapid prototyping- introduction, process and applications

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

CO1 - Understand the difference between traditional and modern manufacturing.
CO2 - Know the key process parameters in each manufacturing process
CO3 - Recognize the capabilities, limitations, and potentials of manufacturing processes
CO4 - Describe the requirements for process automation

Books:

1. Metal Cutting Principles M.C. Shaw Oxford Clarendon Press
2. Metal Cutting Theory and Practice Bhattacharya New Central Book Agency
3. Fundamentals of Metal Cutting and Machine Tools B.L. Juneja and G.S. Sekhon New Age International
4. Principles of Metal Cutting G. Kuppuswamy Universities Press
5. Fundamentals of Machining and Machine Tools D.G. Boothroy and W.A. Knight Marcel Dekker, NY
6. Fundamentals of Metal Casting H. Loper and Rosenthal Tata McGraw Hill
7. Metal forming-Fundamentals and Applications T Altan, Soo-Ik-Oh and H.L. Gegel American Society of Metals, Metal Park, 1983

DEPARTMENTAL ELECTIVE-III

ADVANCED FINITE ELEMENT ANALYSIS

MTME 031

Course Learning Objective:

1. To introduce advanced element used in FE analysis.
2. To introduce nonlinear analysis of structure.
3. To introduce formulation of dynamic problems in FEM
4. To built the ability to model and to solve complex problems in engineering.

Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Mathematical formulation of FEM, Variational and Weighted residual approaches, Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions, Errors, Convergence and patch test, Higher order elements.

Application to plane stress and plane strain problems, Axi-symmetric and 3D bodies, Plate bending problems with isotropic and anisotropic materials, Structural stability, Other applications e.g., Heat conduction and fluid flow problems.

Idealisation of stiffness of beam elements in beam-slab problems, Applications of the method to materially non-linear problems, Organisation of the Finite Element programmes, Data preparation and mesh generation through computer graphics, Numerical techniques, 3D problems, FEM an essential component of CAD, Use of commercial FEM packages, Finite element solution of existing complete designs, Comparison with conventional analysis.

Course Outcomes: At the end of the course, the student will be able to demonstrate knowledge and understanding of-:

CO1 - Plate bending element, shell element, axisymmetric element etc.
CO2 - Non-linear problems using FEA
CO3 - Problems involving dynamics using FEA
CO4 - Application of FEA for analysis of given problem

Books:

1. The Finite Element Method O.C. Zienkiewicz and R.L. Taylor McGraw Hill
2. An Introduction to Finite Element Method J. N. Reddy McGraw Hill
3. Finite Element Procedure in Engineering Analysis K.J. Bathe McGraw Hill
4. Finite Element Analysis C.S. Krishnamoorthy Tata McGraw Hill
5. Concepts and Application of Finite Element Analysis R.D. Cook, D.S. Malcus and M.E. Plesha John Wiley
6. Introduction to Finite Elements in Engineering T.R Chandragupta and A.D. Belegundu Prentice Hall India
7. Finite Element and Approximation O.C. Zenkiewicy & Morgan

INDUSTRIAL AUTOMATION AND ROBOTICS

MTME 032

Course Learning Objective:

1. To acquire knowledge about robot kinematics and dynamics
2. To study the techniques of robot drives and transmission and to study the techniques used in manipulator designs
3. To execute and design a robot for any application

Introduction to Automation: Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.

High Volume Manufacturing Automation: Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines.

Programmable Manufacturing Automation: CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

Flexible Manufacturing Automation: Introduction to Group Technology, Grouping methods, Cell Design, Flexible manufacturing system.

Assembly Automation: Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly systems, Performance evaluation and economics of assembly systems.

Robotics: Review of robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot
classification, End Effectors, Robot kinematics, Object location, Homogeneous transformation, Direct and inverse
kinematics, Manipulator motions, Robot drives, actuators and control, Drive systems, Hydraulic, Pneumatic Electrical DC and AC servo motors and stepped motors, Mechanical transmission method-Rotary-to-rotary motion conversion, Robot motion and path planning control and Controllers, Robot sensing, Range sensing, Proximity sensing, touch sensing, Force and torque sensing etc., Robot vision, Image representation, Image recognition approaches.

Robot Applications: Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics, Future applications.

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

CO1 - Select & identify suitable automation hardware for the given application.
CO2 - Describe & explain potential areas of automation.
CO3 - Differentiate various control aspects of automation.
CO4 - Demonstrate the self learning capability of Industrial Automation.

Books:

1. Automation, Production System & Computer Integrated Manufacturing Groover Prentice Hall India
2. Principles of Automation & Automated Production Process Malov and Ivanov Mir Publication
3. Automation in Production Engineering Oates and Georgy Nowness -
4. Stochastic Models of Manufacturing Systems Buzacott & shanty Kumar Prentice Hall India
5. Robotics K.S. Fu, R.C. Gonzalez, C.S.G. Lee McGraw Hill
6. Robotics J.J. Craig Addison-Wesely
7. Robot Engineering: An Integrated Approach R.D. Klafter, t.a. Chmielewski and M. Negin Prentice

OPERATIONS RESEARCH

MTME 033

Course Learning Objective:

1. Develop mathematical formulation for linear programming and transportation problem
2. Define Queuing system and their characteristics.
3. Construct the required activities in an efficient manner so as to complete it on or before a specified time limit and at the minimum cost.
4. Develop mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.

Introduction: definition and scope of OR; Techniques and tools; Model formulation; general methods for solution; Classification of optimization problems; Optimization techniques.

Linear Optimization Models: Complex and revised simplex algorithms; Duality theorems, sensitivity analysis; Assignment, transportation and transshipment models; Traveling salesman problem as an Assignment problem; Integer and parametric programming; Goal programming.

Game Problems: Mini-max criterion and optimal strategy; Two person zero sum game; Games by simplex dominance rules.

Waiting Line Problems: Classification of queuing situations; Kendall's notation, Poisson arrival with exponential or Erlang service time distribution; Finite and infinite queues; Optimal service rates; Application of queuing theory to industrial problems.

Dynamic Programming: Characteristic of dynamic programming problems (DPPs); Bellman's principle of optimality; Problems with finite number of stages; Use of simplex algorithm for solving DPPs.

Non-linear Programming: One dimensional minimization methods; Unconstrained optimization techniques; Optimization techniques characteristics of a constrained problem; Indirect methods; Search and gradient methods.

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

CO1 - Formulate and solve mathematical model (linear programming problem) for a physical situations like production, distribution of goods and economics.
CO2 - Apply the concept of simplex method and its extensions to dual simplex algorithm.
CO3 - Solve the problem of transporting the products from origins to destinations with least transportation cost.
CO4 - Convert and **solve** the practical situations into non-linear programming problem.

CO5 - Identify the resources required for a project and generate a plan and work schedule.

Books:

1. Operations Research, H.A. Taha, Prentice Hall
2. Engg. Optimization, S.S. Rao, New Age Publication

COMPUTATIONAL FLUID DYNAMICS

MTTE 202

Course Learning Objective:

1. To convert the conservation equations of fluid flow in differential form into algebraic equations and apply numerical methods to obtain solutions.
2. To learn the finite difference method.
3. To learn finite volume method and solution methodology for fluid flow problems

Introduction, Conservation equation, Mass Momentum and Energy equations, Convective form of the equation and general description.

Clarification into various types of equation, Parabolic, Elliptic, Boundary and initial conditions, Overview of numerical methods.

Finite difference methods; Different means for formulating finite difference equations, Taylor series expansion, Integration over element, Local function method; Finite volume methods; Central, upwind and hybrid formulations and comparison for convection-diffusion problem, Treatment of boundary conditions; Boundary layer treatment; Variable property, Interface and free surface treatment, Accuracy of F.D. method.

Solution of finite difference equations; Iterative methods; Matrix inversion methods, ADI method, Operator splitting, Fast Fourier Transform applications.3

Phase change problems, Rayleigh-Ritz, Galerkin and Least square methods; Interpolation functions, One and two dimensional elements, Applications. Phase change problems; Different approaches for moving boundary; Variable time step method, Enthalpy method.

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

CO1 - Understand solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly
CO2 - Define and setup flow problem properly within CFD context, performing solid modeling Using CAD package and producing grids via meshing tool
CO3 - Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution
CO4 - Use CFD software to model relevant engineering flow problems. Analyse the CFD results. Compare with available data, and discuss the findings.

Books:

1. Computational Methods for Fluid Dynamics Ferziger Joel H Springer-Verlog
2. Principles of Heat Transfer Kaviany M Wiley-International
3. Radiative Heat Transfer Modest Michael Academic Press
4. Middleman Stanley John Wiley

DEPARTMENTAL ELECTIVE-IV

TOTAL QUALITY MANAGEMENT

MTME 041

Course Learning Objective:

1. Develop an understanding on the necessary information and skills needed to manage, control and improve quality practices in the organizations through TQM philosophy.
2. Explain the four revolutions in management thought processes.
3. Apply the reactive and proactive improvement methodologies for problem solving in organizations.
4. Demonstrate the importance of team work in problem solving processes.
5. Define the business excellence models implemented in various organizations.

Introduction and Components of TQM: Concept and Philosophy of TQM, Value and Quality assurance, Total Quality Control, Quality policy, Team-work and participation, Quality cost measurement, Quality Circle, Customer/Supplier integration, Education and training.

Tools and Techniques of TQM: Statistical method in quality control, Process control chart, Acceptance sampling plan, Statistical Productivity control (SPC)

Reliability: Failure analysis, System reliability and redundomy

TQM implementation: Steps in promoting and implementing TQM in manufacturing industries, Industrial Case studies.

ISO 9000 Quality Systems: Concepts, designation Standards, Quality system documentation, Quality manual, Quality procedures and work inspection.

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

CO1 - Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.
CO2 - Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
CO3 - Critically appraise the organisational, communication and teamwork requirements for effective quality management
CO4 - Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans

Books:

1. Total Quality Control F. Ammandev Tata McGraw Hill
2. Total Quality Management Besterfield, et. al. Prentice Hall of India
3. Total Quality Management: Text and Cases B. Janakiraman & RK Gopal Prentice Hall of India
4. What is Total Quality Control? K. Ishikawa Prentice hall
5. Total Quality Management: The Route to Improving Performance J.S. Oakland Butterworth Heineman Oxford
6. Out of Crisis W.E Dming Centre of Advance Engineering Study, Cambridge

ADVANCED WELDING TECHNOLOGY

MTME 042

Course Learning Objective:

1. To impart knowledge on various advanced welding processes so that the students can apply them in engineering industry applications.
2. To develop the knowledge on the design of welded joints and the quality control of weldments

Welding Metallurgy: Welding as compared with other fabrication processes, Classification of welding processes; Heat affected zone and its characteristics; Effects of alloying elements on weldability, Weldability of steels, stainless steel, cast iron, and aluminum and titanium alloys, Weld testing standards, Hydrogen embrittlement, Lammellar tearing, residual stresses and its measurement, heat transfer and solidification, Analysis of stresses in welded structures, Pre and post welding heat treatments, Metallurgical aspects of joining, Conditions of soldering, Brazing and welding of materials.

Weld Design & Quality Control: Principles of sound weld design, Welding joint design, Welding defects; Testing of weldament, Material joining characteristics, Welding positions, Allowable strength of welds under steady loads, Weld throat thickness; Weld quality, Discontinuities in welds, their causes and remedies and quality conflicts.

Modern Trends in Welding: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Plasma arc welding, Laser welding.

Mechanisation in Welding: Mechanisation of flat/circular joints, Thin/thick sheets (resistance/arc weld), Mechanisation of I beams (arc weld), Longitudinal circumferential SA welding (roller blocks, column booms, flux supports), Circular/spherical welding joints (rotating tables positioners), Manufacture of welding longitudinal welded pipes by induction, TIG, Plasma and SA welding of spiral welded pipes.

Robotics in Welding: Robot design and applications in welding, Programming of welding robots, tolerances for assemblies for robot welding, New generation of welding robots, Self alignment by current arc variation, Robots for car body welding, Microelectronic welding and soldering, Efficiency of robotics in welding.

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

CO1 - Apply the knowledge of solid state welding process for engineering applications
CO2 - Understand the fundamental principles of special arc welding process
CO3 - Understand the knowledge of plasma arc in metal joining and cutting process.
CO4 - Understand the knowledge of design principles in weld joints. Apply the concept of quality control and testing of weldments in industrial environment

Books:

1. Advanced Welding Processes Nikodaco & Shansky MIR Publications
2. Welding Technology and Design VM Radhakrishnan New Age International
3. Source Book of Innovative welding Processes M.M. Schwariz Americal Society of Metals (Ohio)
4. Advanced Welding Systems, Vol. I, II, III J. Cornu Jaico Publishers
5. Manufacturing Technology (Foundry, Forming and Welding) P.N. Rao Tata McGraw Hill

ADVANCED MECHANICAL DESIGN

MTME 043

Course Learning Objective:

1. To study design concepts in order to enhance the basic design.
2. To study behaviour of mechanical components under fatigue and creep.
3. To study statistical techniques and its applications in mechanical design.

Introduction: Concepts related to kinematics and mechanisms, Degrees of freedom, Grubler's Criteria, Transmission and Deviation angles, Mechanical advantage.

Kinematic Synthesis: Type, number and dimensional synthesis, Spacing of accuracy points, Chebyshev polynomials, Motion and function generation, Graphical synthesis with two, three and four prescribed motions and points, The complex number modeling in kinematic synthesis, The Dyad, Standard form, Freudentein's equation for three point function generation coupler curves, Robert's law, Cognates of the slider crank chain.

Path Curvature Theory: Fixed and moving centrode, Inflection points and inflection circle circle, Euler'-savary Equation, Bobillier's and Hartsman construction.

Dynamic Force Analysis: Introduction, Inertia force in linkages, Kineto static analysis by superposition and matrix approach, Time response of mechanisms, Force and moment balancing of linkages.

Spatial Mechanism: Introduction to 3-dimensional mechanisms, Planar Finite, Rigid body and spatial transformation, Analysis of spatial mechanisms.

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

CO1 - Analyze mechanical elements critically.
CO2 - Analyze behaviour of mechanical elements under fatigue and creep.
CO3 - Understand applications of statistical techniques in mechanical design.

Books:

1. Fundamentals of applied Kinematics D.C. Tao Addison Wesley
2. Kinematic Synthesis of Linkages R. Hartenberg and Denavit McGraw Hill
3. Kinematic Analysis and Synthesis of Mechanisms A.K. Mallik and A. Ghosh CRC Press
4. Theory of Mechanisms A.K. Mallik and A. Ghosh East west Press
5. Kinematics and Dynamics of Plane Mechanisms J. Hirschern McGraw Hill, NY
6. Mechanism Synthesis & Analysis Soni McGraw Hill

Advanced Engineering Materials

MTME 044

Course Learning Objective:

1. Distinguish various classes of advanced materials.
2. Identify various classes of composite materials, their properties and applications.
3. Define the advance alloy, conductive material and its properties

Ferrous Materials:

Introduction, Fe-C phase diagram, various invariant reactions observed in Fe-C phase diagram, steel, low carbon steel, dual phase steels, micro alloying steels, weathering steels, free cutting steels, medium carbon steels, high strength structure steels, ausformed steels, martensitie stainless steels, Tool materials classification, properties, heat treatment of high speed steel, Tool for cold and hot forming, tools for high speed cutting, cast iron, Grey cast iron, white cast iron, malleable cast iron, nobular cast iron or ductile iron, vermicular graphite iron, properties and applications.

Non Ferrous Materials, Super Alloys, Bio-Materials:

Introduction, Types of non Ferrous materials, Cu and Cu alloys, properties and applications, aluminum, cast aluminum alloys, wrought aluminum alloys, properties and Applications, Ti and its alloys, properties and applications Mg and its alloys, propertics and applications, super alloys : Ni, Fe and Co based alloys, properties and applications, bio-materials, bio compatibility, applications and properties.

Polymeric Materials:

Introduction to thermoplastic and thermosettting plastics, industrial polymerization method, processing of plastic materials, processes used for thermoplastic materials, injection moulding, extrusion, blow moulding and thermo forming, properties and applications, Processes used thermosettting materials, compression moulding, transfer moulding and injection moduleing, Ceramic materials: processing of ceramics, forming – pressing, dry pressing, isostatic pressing, hot pressing, slip casting , extrusion, thermal treatment, vitrification, properties and applications, Engineering ceramics – alumina, silicon nitrite, silicon carbide, magnetic materials, magnetic fields, Types of magnetism, soft magnetic materials, properties and applications.

Composite Material, Semi and Super Conducting Materials:

Hard magnetic materials, properties and applications, Composite materials : classification, MMC's preparation of composite materials, properties and applications, FRP contains composites preparation of composite materials, properties and applications, particulate RP composite, preparation of composite materials, properties and applications, semi conducting materials, intrinsic and extrinsic semi conduction, semi-conductor devices, properties and applications, super conducting materials, current flow and magnetic fields, high critical temperature, super conducting oxide.

Advanced Materials and Properties of Metal and Alloys:

Smart materials: classification, piezo electric materials, Rheological materials, smart gets, chromic materials, thermo responsive materials magnetostrictive materials, elertrostricitve materials, nanotechnology materials synthesis, properties, carbon nanotechnology tubes and applications.

Course Outcomes: At the end of the course, the student will be able to;
CO1. Students will recognize how the internal structure of a material (both at the micro and macro levels) controls the mechanical properties.
CO2. Define the basic properties and characteristics of metal/polymers/ceramics;
CO3. Student understand the property of advanced alloys, different conductive materials.

Books:

1. Materials Science of Thin Films, 2nd Edisiotn, Milton Ohring, Academic Press, 2002
2. Materials Science and Engineering, An Introduction, 5th Edition, William D. Callister, Jr., JohnWiley & Sons, Inc., New York, 1999, with CD-ROM.
3. Fundamentals of Modern Manufacturing, Materials, Processing, and Systems, 2nd edition, Mikell P.Grrover, John Wiley & Sons, inc.,

ELECTIVE-V

FLEXIBLE MANUFACTURING SYSTEM

MTME 051

Course Learning Objective:

1. Understand the role of Flexible Manufacturing Systems (FMS) in manufacturing,
2. Understand the concept of Group Technology
3. Understand the concept of Cellular Mfg Systems
4. Understand the benefits of automation,
5. Know types of manufacturing industries,
6. Be familiar with organization and information processing in manufacturing,
7. Have a basic knowledge of automation equipment,
8. Understand logic control and associated technologies

Introduction: FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Use of different algorithms,

mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production. FMS related problem and Solution Methodology: · FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.

· FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.

· Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.

· FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

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

CO1 - Apply the concepts of PPC and GT to the development of FMS.

CO2 - Discuss the planning and scheduling methods used in manufacturing systems.

CO3 - Identify various workstations, system support equipments.

CO4 - Identify hardware and software components of FMS.

CO5 - Summarize the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

Books:

1. Automation, Production System & Computer Integrated Manufacturing Groover Englewood
2. Design and Operation of SMS Rankey IFS
3. Flexible Manufacturing System Wernecks Spring-Verlag
4. FMS in Practice Bonctto Northox Ford
5. Flexible Manufacturing Cells and systems W.W. Luggen Prentice Hall India
6. Performance Modelling of Automated Manufacturing Systems Vishwanathan

MACHINE VISION

MTME 052

Course Learning Objective:

1. To learn the fundamentals of vision systems
2. To understand the image recognition and retrieval algorithms
3. To learn the concepts of object recognition and applications of vision systems

Image capture and digitization; Image transforms; Digital Fourier transform; Fast Fourier transform; Other transforms; Convolution; Image enhancement; Spatial methods; Frequency domain methods; Image restoration.

Geometric transformation; Image compression; error free and lossy compression; Edge detection; Hough transform; Region based segmentation; image feature / region representation and descriptors; Morphological operators.

Feature based matching; Baye's classification; Low level vision; Introduction to stereopsis, Shape from shading; Optical flow; Rule based picture segmentation; tutorial exercise will emphasize development and evaluation of image algorithms.

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

CO1 - Able to know the basics concepts of vision systems.
CO2 - To apply the vision concept of designing robots.
CO3 - To use the algorithms to image processing

Books:

1. Image Processing, Analysis and Machine Vision Milan Sanka, Vaclav Hlavac and Roger Boyle Vikas Publishing
2. Digital Image Processing Kenneth & Castleman Prentice Hall India
3. Digital Image Processing Conzalez RC & P Wint Addision Wesley
4. Digital Image Processing & Analysis Chandra and Mazumdar Prentice Hall India

ADDITIVE MANUFACTURING AND TOOLING

MTME 053

Course Learning Objective:

1. Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available
2. Learn how to create physical objects that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
3. Understand the latest trends and business opportunities in AM, distributed manufacturing and mass customization.

Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping process chains, 3D modeling and mesh generation, Data conversion and transmission.

RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RP systems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc., Power based rapid prototyping systems, selective Laser sintering, Soligen Diren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data.

RP Applications: Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields, Development of bone replacements and tissues, etc., RP materials and their biological acceptability.

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

CO1 - Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available

CO2 - Understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.
CO3 - Understand the latest trends and business opportunities in AM, distributed manufacturing and mass customization

Books:
1. Rapid Prototyping Of Digital Systems: A Tutorial Approach Hamblen James O Kluwer Aca
2. Rapid Prototyping: Principles And Applications Kai Chua Chee World Scie
3. Rapid System Prototyping With Fpgas: Accelerating The Design Process R C Cofer Newnes
4. Rapid Prototyping of Digital Systems James O Hamblen Springer

Machine Tool Engineering

MTME 054

Course Learning Objective:

1. The course aims in identifying the classification of unconventional machining processes.
2. To understand the principle, mechanism of metal removal of various unconventional machining processes.
3. To study the various process parameters and their effect on the component machined on various unconventional machining processes.
4. To understand the applications of different processes

Introduction of Machine Tools
Basic concepts of Machining and Machine Tools, Classification of Machine Tools , Working and auxiliary motions in machine tools, Primary cutting motions in machines tools, CNC machining.

Turning operations
Introduction – Lathe – Types of lathes – Size of a lathe – Work holding devices – Principal unit arrangements and mechanisms to obtain speed, feed and depth of cut- Lathe operations – Metal removal rate and machining time calculations- Turrets and automats-Micro turning-CNC turning- Alignment test for Lathe.

Drilling and allied operations
Introduction – Drilling machines – Types - mechanism deployed for speed, feed and depth of cut – Drills – Drilling machine operations – Boring, Reaming and other operations – Material removal rate and time calculations for drilling -Methods of drilling, deep hole drilling, micro drilling, multiple drilling, CNC drilling- Alignment test for drilling- - Boring machine – Types.

Milling operations:

Introduction – Milling machines and mechanism deployed for speed and feed and Types of Milling machines – Milling cutters – Milling process- work holding devices – milling machine attachments- Milling machine operations-alignment test for milling machine-Micro milling, horizontal and vertical CNC centres- Material removal rate and time calculations for milling.

Shapers, Planers and Slotters

Classification of Planers, Shapers and Slotters, Speed, feed and depth of cut of Planers, Shapers and Slotters, Material removal rate and time calculations for Planers, Shapers and Slotters, drive and feed mechanisms of Planers, Shapers and Slotters.

Broaching Operations:

Principles- Types of broaching machines- advantage, applications and limitations of broaching.

Abrasive Processes:

Basic principle- purpose and application of grinding- Selection of grinding wheels and their conditioning- Classification of grinding machines and their uses-Micro grinding-alignment test for grinding machine- Material removal rate and time calculations for grinding.

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

CO1 - Differentiate various metal forming processes such as Hot and Cold Working, Rolling, Forging, Extrusion and Drawing Processes

CO2 - Demonstrate operation such as Turning, Facing, Threading, Knurling and Grooving on Centre Lathe

CO3 - Select appropriate Joining Processes to join Work piece.

Reference Books:

1. Hajra Choudhary S.K. and Hajra Choudhary A.K ., "Workshop Technology", Media Promotors and Publishers,1992.
2. Workshop Technology Vol. I &II & III by Chapman.1972
3. Production Technology by R. K. Jain. Khanna Publishers, 2001
4. Processes and Materials of Manufacture; Lindberg Roy A.; Prentice-Hall India 1998
5. Kalpakjain S. and Schmid Steven R., "Manufacturing Processes for Engineering Materials ", Pearson Publication, 2007.
6. Bawa H.S., "Workshop Technology", Tata McGraw Hill, 1995.