B. Tech (Mechanical Engineering) 5th Semester

CODE	COURSE	L	T	P	Credits
MEPC301	Machine Design I**	2	0	4	4
MEPC302	Production Technology – II	3	0	0	3
MEPC303	Heat Transfer	3	0	0	3
MEPE***	Any one subject from Group III	3	0	0	3
MEPE***	Any one subject from Group IV	3	0	0	3
OE*		3	0	0	3
MEPC312	Production Technology – II (P)	0	0	2	1
MEPC313	Heat Transfer (P)	0	0	2	1
MEIC314	Internship/Industrial Training/Project viva-voce (4-6 weeks duration after 4th semester examination)				2
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				23

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester*

*****Not to be counted towards integrated course***

PROGRAM ELECTIVES

GROUP - III		GROUP - IV	
CODE	COURSE	CODE	COURSE
MEPE304	Material Science	MEPE308	Thermal Power Engineering
MEPE305	Rapid Product Development	MEPE309	Nuclear Engineering
MEPE306	Work Study & Ergonomics	MEPE310	Computational Fluid Dynamics
MEPE307	Advanced Welding Technology	MEPE311	Renewable Energy Systems

B. Tech (Mechanical Engineering) 6th Semester

CODE	COURSE	L	T	P	Credits
MEPC315	Machine Design II**	2	0	5	4
MEPC316	Refrigeration & Air Conditioning	3	0	0	3
MEPE***	Any one subject from Group V	3	0	0	3
MEPE***	Any one subject from Group VI	3	0	0	3
OE*		3	0	0	3
MEPC327	Refrigeration & Air Conditioning (P)	0	0	2	1
MEPC328	Technical Discussions	0	0	2	1
SWNC101	NCC/Sports/Yoga	0	0	4	2*
SWNC102	NSS/Clubs/Technical Societies	0	0	4	2*
	Total Credits				22

***** *Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester*
based on Cumulative performance up to 6th Semester

*****Not to be counted towards integrated course***

PROGRAM ELECTIVES

GROUP - V		GROUP - VI	
CODE	COURSE	CODE	COURSE
MEPE317	Logistics & Supply Chain Management	MEPE322	Tribology
MEPE318	Operations Research	MEPE323	Mechatronics
MEPE319	Reliability & Maintenance Engineering	MEPE324	Finite Element Method
MEPE320	Advanced Manufacturing Processes	MEPE325	Vehicle Dynamics
MEPE321	Additive Manufacturing	MEPE326	Mechanics of Composite Materials

B. Tech. (Mechanical Engineering) 7th Semester

CODE	COURSE	L	T	P	Credits
MEPC401	IC Engines and Gas Turbines	3	0	0	3
MEPC402	Mechanical Vibrations	3	0	0	3
MEPC403	Computer Aided Design	3	0	0	3
MEPE***	Any one subject from Group VII	3	0	0	3
MEPE***	Any one subject from Group VIII	3	0	0	3
OE*		3	0	0	3
MEPC412	IC Engines and Gas Turbines (P)	0	0	2	1
MEPC413	Mechanical Vibrations (P)	0	0	2	1
MEPC414	Computer Aided Design (P)	0	0	3	1
MEIC415	Internship/Industrial Training/Project viva-voce (4-6 weeks duration after 6th semester examination)				2
	Total Credits				23

PROGRAM ELECTIVES

GROUP - VII		GROUP - VIII	
CODE	COURSE	CODE	COURSE
MEPE404	Computer Integrated Manufacturing	MEPE408	Project I
MEPE405	Product Design & Development	MEPE409	Artificial Neural Network
MEPE406	Engineering Economy	MEPE410	Fatigue, Fracture & Failure Analysis
MEPE407	Production Planning and Control	MEPE411	Two Phase Heat Transfer

B. Tech. (Mechanical Engineering) 8th Semester

CODE	COURSE	L	T	P	Credits
MEIC416	Entrepreneurship and Start-ups	3	0	0	3
MEIC417	Metrology & Measurements	3	0	0	3
MEPE***	Any one subject from Group IX	3	0	0	3
MEPE***	Any one subject from Group X	3	0	0	3
OE*		3	0	0	3
MEIC426	Metrology & Measurements (P)	0	0	2	1
	Total Credits				16

PROGRAM ELECTIVES

GROUP - IX		GROUP - X	
CODE	COURSE	CODE	COURSE
MEPE418	Quality Control and Assurance	MEPE422	Project II
MEPE419	Six Sigma: Concepts and Methodology	MEPE423	Thermal Design and Management of Electronic Equipment
MEPE420	Total Quality Management	MEPE424	Automobile Engineering
MEPE421	Facilities Design	MEPE425	Industrial Robotics

List of Open Electives to be offered by Mechanical Engineering Department

Odd Semester		Even Semester	
CODE	COURSE	CODE	COURSE
MEOE427	Reliability & Maintenance Engineering	MEOE431	Nuclear Engineering
MEOE428	Total Quality Management	MEOE432	Renewable Energy Systems
MEOE429	Logistics & Supply Chain Management	MEOE433	Engineering Economy
MEOE430	Industrial Engineering and Management	MEOE434	Thermal Design and Management of Electronic Equipment

Semester	I	II	III	IV	V	VI	VII	VIII
Credits	20	20	21	21	23	22	23	16

Total credits = 166

Semester/Course type	I	II	III	IV	V	VI	VII	VIII	Total	% weightage
IC	18	14	4	-	2	-	2	3	43	25.90
PC	-	4	17	21	12	9	12	4	79	47.59
PE	-	-	-	-	6	6	6	6	24	14.46
OE	-	-	-	-	3	3	3	3	12	7.23
NC	2	2	-	-	-	4	-	-	8	4.82
Total	20	20	21	21	23	22	23	16	166	100.00

MINOR IN INDUSTRIAL MANAGEMENT

A student from other than ME & PIE branches can register in minimum five courses (CREDITS 15) to earn minor degree.

Sr. No.	Course code	Name of the course	Core/Elective course	Pre-requisite	Credits
1	MEPC212	Industrial Engineering	Core	NIL	3
2	MEPE420	Quality Control and Assurance	Core	NIL	3
3	MEPE318	Operations Research	Elective	NIL	3
4	MEPE407	Production Planning and Control	Elective	NIL	3
5	MEPC319	Reliability & Maintenance Engineering	Elective	NIL	3
6	MEPE317	Logistics & Supply Chain Management	Elective	NIL	3
7	MEPE406	Engineering Economy	Elective	NIL	3
8	MEPE419	Six Sigma: Concepts and Methodology	Elective	NIL	3
9	MEPE421	Facilities Design	Elective	NIL	3
10	MEPE306	Work Study & Ergonomics	Elective	NIL	3
11	MEPE408	Project I	Elective	NIL	3

MEPC301: MACHINE DESIGN-I

Pre-requisite: **Strength of Materials-II, Dynamics of Machines**

L	T	P	Credits	Total contact hours
2	-	4	4	80

Brief Description about the course

Machine Design-I is the first course in an in-depth two course series of Machine Design. This course will integrate the knowledge of Statics, Dynamics, Strength of Materials and Engineering Materials into the design process of machine elements. Students will learn the fundamentals of the design process, and the design of some common machine elements includes screws, fasteners, shafts, couplings and levers will be the focus.

UNIT - I

Concepts of Design: Design methodology, Classification of machine design and the general considerations, Design criterion based on fracture, deformation and elastic stability, Design stresses, Factor of safety, Selection of Engineering Materials, stress concentration, causes and mitigation, Endurance limit, Notch sensitivity, Size and surface finish, Goodman diagram, Gerbers parabola and Soderberg line.

Manufacturing Considerations: Manufacturing considerations in design, design of castings and weldments. **(16 hrs)**

UNIT – II

Design of joints: Riveted joints for boiler shell according to I.B.R., riveted structural joint, and riveted joint with eccentric loading. Types of welded joints, strength of welds under axial load, Welds under eccentric loading, designation of various types of bolts and nuts, Design of bolted joints, Bolts of uniform strength, Bolted joints with eccentric loads, Pipe joints, Cotter joint and knuckle joints. **(24hrs)**

UNIT – III

Design of Shaft: Design of shafts subjected to pure torsion, pure bending load, Combined bending & torsion, combined torsion, bending and axial loads, Design of shaft on the basis of rigidity.

Design of Keys and Couplings: Design of keys, Types of shaft couplings, Design of sleeve or muff coupling, flange coupling and bush type flexible couplings.

(20 hrs)

UNIT – IV

Design of Levers: Introduction, hand and foot levers, cranked levers, lever for a lever safety valve, Bell crank lever, miscellaneous levers.

Power screw: Function, types of power screws, stresses in screws, Self locking screw, Design of Screw jack, Differential and Compound Screws.

Case Studies: Crimping tool failure analysis, Bicycle brake arm stress analysis, designing driveshafts for a portable air compressor, design of the head bolts for an air compressor.

(20 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Mechanical Engineering Design- Shigley, Mischke, and Budynas, McGrawHill
2. Design of Machine Elements - Bhandari, Tata McGraw-Hill
3. Machine Design - Sharma and Aggarwal, Kaston Public.
4. Machine Design – An Integrated Approach - Robert L. Norton, Prentice-Hall Inc.
5. Fundamentals of Machine Component Design -R.C. Juvinall, John Wiley & Sons

Course Outcomes

The student will be able to
CO 1: calculate stresses involved with static/fatigue loading.
CO 2: design power transmission elements like shaft, keys and couplings for rotating machinery.
CO 3: understand the design and applications of different types of joints.
CO 4: design levers and fasteners for machines.

MEPC302: PRODUCTION TECHNOLOGY-II

Pre-requisite: PT-I

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

It explore to an extensive view of types of metal removal process in unconventional machining processes such as Ultrasonic machining, Electric discharge machining, etc. there involved of various types of machining operations such as gear manufacturing methods, Press working tools applications and various clamping devices. It helps to understand the fundamental concept of non-conventional machining process selections decision for match the specific requirement of products structures & features suitability.

UNIT- I

Unconventional Machining Processes

Need for unconventional processes, Ultrasonic machining, Electric discharge machining, Electrochemical machining, Electrochemical grinding, Laser beam machining, Electron beam machining – their mechanism of metal removal, process parameters, advantages, limitations and applications. (**9 hrs**)

UNIT- II

Capstan and Turret Lathe

Limitations of a center lathe, Introduction to Capstan and Turret lathe, Universal Bar equipment, tool layout for simple parts. (**4 hrs**)

Gear Manufacturing

Classification of gear production methods, gear generation – gear hobbing, gear shaping, gear finishing methods – shaving, burnishing, grinding, lapping, honing. **(5 hrs)**

UNIT-III

Press Working Tools

Introduction, classification of presses, shearing action, cutting forces, clearance and its effect, shear, angular clearance, stripper, Types of dies – Progressive, compound and combination, center line of pressure and its mathematical calculation. (**7 hrs**)

Jigs and Fixtures

Introduction, difference between jig and fixture, principles of location, locating and clamping devices, Jig bushes, Milling fixtures, Turning fixtures, Different Materials for jigs and fixtures, Economics of Jigs and Fixtures. (**7 hrs**)

UNIT- IV

Metal Forming

Metal flow condition, plasticity conditions for plain strain, Friction conditions in metal working, Analysis of forming processes wire drawing , extrusion of circular rods, Theory of forging for plates. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference:

1. Modern Machining Processes by Pandey & Shan, Tata – Mc Graw Hill
2. Advanced Machining Processes by V. K. Jain, Allied Publishers Pvt. Ltd.
3. Manufacturing Science by Ghosh & Mallick, Affiliated East West Press.
4. Tool Design by Donaldson, Mc Graw Hill
5. Manufacturing Technology:by P.N. Rao, Tata Mc Graw Hill Metal Cutting Principles by Milton C. Shaw, MIT Press, Cambridge
6. Production Engineering Science by P. C. Pandey and C. K. Singh, Standard Publishers

Course Outcomes

CO1: To understand the non-conventional machining process selections for specific work piece requirements.
CO2: To understand the gear and threads manufacturing methods for work pieces requirements.
CO3: To understand the press working tools and location of clamping devices of various production environments.
CO4: To understand the theory of wire drawing, extrusion and forging processes.

MEPC303: HEAT TRANSFER

Pre-requisite: Thermodynamics, Fluid Mechanics

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

The course provides the knowledge about: - Basic heat transfer mechanisms (conduction, convection and radiation). Heat transfer by conduction in solids for steady-state and transient conditions. Heat transfer by convection in closed conduits and on external surfaces. Heat transfer by thermal radiation. Heat transfer with phase change (boiling and condensation). The course gives the insight about: Boundary layer flow, laminar and turbulent flows. Heat exchangers: Working principles and basic geometries. The learner will be able to apply the concepts of heat transfer in all the related engineering applications.

UNIT - I

Modes of heat transfer, energy carriers and continuum approximation. Mechanisms of mass transfer. Unified view of momentum, heat and mass transfer. Conduction: Fourier's law, heat diffusion equation, 1-D steady state conduction in different coordinate systems, effect of heat generation. Heat conduction in extended surfaces. Lumped capacitance and 1D transient models, semi-infinite wall. **(10 hrs)**

UNIT – II

Convection: Forced and free convection - mass, momentum and energy conservation equations, scaling analysis and significance of non-dimensional numbers. Thermal boundary layers, heat transfer in external and internal laminar and turbulent flows.

(10 hrs)

UNIT – III

Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems. Heat exchanger types and analysis: LMTD and effectiveness-NTU method. **(10 hrs)**

UNIT – IV

Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity, reflectivity & transmissivity. Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between blackbodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Heat Transfer Incropera and Dewitt, Willey publications
2. Heat Transfer: J.P.Holman, TMH Publications
3. Heat Transfer: P.S.Ghosdastidar, Oxford University Press
4. Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age International Publishers, 4th Edition
5. Heat Transfer by P.K. Nag, TMH
6. Heat Transfer by S.P. Sukhatme, TMH
7. Heat Transfer: A.F.Mills and V.Ganesan, Pearson Education, 2nd Edition
8. Heat and Mass Transfer: Domkundwar and Arora, Danpatrai and sons
   Heat Transfer: R.K.Rajput, Laxmi Publications
9. Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, Tata Macgraw Hills Education Private Limited

Course Outcomes:

CO 1: The students will be able to describe the principles of heat mechanisms, combustion, heating/cooling systems in its fundamental aspects with relation to existing energy systems.

CO 2: The students will be able to apply relationship between theoretical and practical aspects of heat transfer applications.

CO 3: The students will be able to analyze principles of energy mechanisms to solve a wide range of thermal engineering problems.

CO 4: The students will be able to develop solutions for mathematical models and propose appropriate results for thermal engineering applications.

MEPC312: PRODUCTION TECHNOLOGY-II (P)

Pre-requisite: **PT-I (P)**

L	T	P	Credits	Total contact hours
0	0	2	1	24

Brief description about the course

This course will give hands on training to the undergraduate students for various experiments related to production technology such as MIG/TIG welding, Wire EDM, CNC turning/milling, Tool Life equation, Rotary USM etc. Students will learn to use the equipment and perform practical on the same.

Course Contents:

1. To perform different operations of CNC turning center and measure the force and vibration during machining
2. To perform machining (square shape) on CNC-wire cut EDM machine and study the effect of electrical parameters on Cutting speed
3. Study and experiment on Robotic Pulse MIG welding cell
4. Study and experiment on robotic pulse TIG Welding Cell
5. To Perform milling operation on CNC Vertical milling Center and measure cutting force during milling
6. To Perform drilling operation on Rotary Ultrasonic Machining Set up
7. Gear cutting by milling and hobbing processes
8. Testing the sand properties- mould harness and grain size
9. Study and experiment on tool life in turning operation

Course Outcomes:

At the end of the lab course student will be able to:

MEPC313: HEAT TRANSFER (P)

Pre-requisite: TD

L	T	P	Credits	Total contact hours
-	-	2	1	24

List of Experiments

1. Determination of thermal conductivity of a metal rod
2. Determination of thermal conductivity of an insulating powder
3. Determination of thermal conductivity of a liquid using Guard-plate method
4. Determination of thermal resistance of a composite wall
5. Temperature distribution of a pin fin in free-convection.
6. Temperature distribution of a pin fin in forced-convection
7. Forced convection heat transfer from a cylindrical surface
8. Determination of Effectiveness of a Heat Exchanger
9. Determination of Stefan-Boltzman constant.
10. Performance of Solar still
11. Determination of critical heat flux
12. Performance of solar water heater
13. Measurement of solar radiation using solar integrator.

MEPE304: MATERIAL SCIENCE

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	46

Brief description about the course

This course will introduce the students to concepts of crystallography, alloy formation, and phase diagrams. Various mechanisms of plastic deformation, strengthening mechanisms, and mechanical properties of engineering material will be discussed. The students will gain useful knowledge about heat treatment procedures adopted in the industries and their effect on mechanical properties. The students will also learn about the various types of engineering materials for different applications.

UNIT -I

Introduction to crystallography and alloy formation: Bonding in Solids: Ionic, Amorphous and Crystalline, Single crystal and Polycrystalline material, Polymorphism, Lattice, Unit cell, Bravais lattice, Types of crystals, Linear and Planer densities, Voids in crystalline structures, Crystal defects (Point, Line, Surface and Volume defects), Solid solution, Hume-Rothery rules, Binary phase diagrams: Gibbs phase rule, lever rule, cooling curves, Types of Binary phase diagrams (Isomorphous, Eutectic, Partial-Eutectic systems), Iron-Carbon phase diagram.

(12 hrs)

UNIT-II

Plastic deformation and Mechanical Properties: Tensile Test: Elastic and Plastic deformation and Strain hardening with respect to Stress-Strain Curve, Plastic deformation by Slip: Slip system, Critical resolved shear stress, Frank-Read source, Dislocation motion, Work hardening and dynamic recovery, work softening, Bauschinger's effect, grain boundaries, its effect on crystal and on strength, grain size, low angle grain boundaries, Strengthening Mechanisms, Recovery, Recrystallization, and Grain growth, Cold and hot working, Impact Test, Fatigue failure, SN curve, Methods of improving fatigue life, Creep Test: Creep curve, Creep fracture, Material consideration for high-temperature use. **(12 hrs)**

UNIT-III

Heat Treatment: Purpose of Heat treatments, Equilibrium and Non-equilibrium cooling, Nucleation, Grain growth and Kinetics, TTT and CCT diagrams Common heat treatments like Annealing, Normalizing, Hardening, Tempering, Martempering, and Austempering, Precipitation hardening, Hardenability: Jominy end-quench test, Hardenability curves, Surface hardening (carburizing, Nitriding, carbo-nitriding, cyaniding, Flame, and Induction hardening).

(12 hrs)

UNIT-IV

Engineering Materials: Metals (Iron, Copper, Aluminium, Magnesium, Titanium etc., Alloys (Fe-alloys, Al-alloys, Mg-alloys, Copper Alloys, Titanium Alloys, etc.), Polymers: Thermoplastic and Thermosetting polymers, Ceramics: Types of ceramics, applications, Powder Metallurgy, Composites: Classification, applications. Case study: study of the microstructure, phases, mechanical behaviour and effect of heat treatment on steel specimen. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Material Science and Engineering - V. Raghavan, Prentice Hall
2. Materials Science and Engineering An Introduction - W.D. Callister, John Wiley
3. Mechanical Behaviour of Materials – McClintock & Argon, Addison-Wesley
4. Mechanical Behaviour of Materials - Courtney, McGraw-Hill
5. Mechanical Metallurgy-Dieter

Course Outcomes

CO 1: Understand and distinguish between the various types of bonding in solids, defects in materials, and phase diagrams.
CO 2: Explain the mechanism of plastic deformation, strengthening, and behavior of materials under various types of loading conditions.
CO 3: Explain and suggest heat treatment techniques to improve the mechanical properties of various types of steel
CO4: Suggest the use of engineering materials for different applications

MEPE305: RAPID PRODUCT DEVELOPMENT

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Rapid Product Development course will focus on different rapid prototyping techniques and tools to build product in less time.

UNIT I

Computer Aided Design and Computer aided Manufacturing (CAD-CAM) and its integration, Rapid Prototyping (RP), Product development and its relationship. AM/3D printing process chain: Conceptualization, CAD, STL file, Transfer to 3D printing, STL file manipulation, Repair of STL files, Machine setup, build, removal and clean up, post processing. Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, solid sheet system. Process chain for Rapid Prototyping, Reverse Engineering and CAD model, Digitizing Techniques: Contact and Non-contact based, Coordinate measuring machine (CMM), Computed Tomography (CT) and 3D scanning**.** **(10 hrs)**

UNIT II

Factors affecting part orientation, support structure design, Automatic support structure generation. Model Slicing and Contour Data organization: Model slicing and skin contour determination, Identification of external and internal contours, Contour data organization, Direct and adaptive slicing: (**10 hrs)**

UNIT III

Parameters affecting part building time in Fused Filament Fabrication (FFF) and powder Bed fusion process printer, Recoating, part quality. Part removal, finishing, curing. Other issues: Shrinkage, Swelling, Curl and distortion, Surface Deviation and accuracy, Build Style Decisions, different defects in built 3D printing component and remedies**.** **(10 hrs)**

UNIT IV

Rapid Tooling and Manufacturing: Classification of Rapid Tooling Routes, Rapid Prototyping of Patterns, Direct Rapid Tooling: Direct Rapid Tooling method for Soft and Bridge Tooling, Indirect Rapid Tooling: Indirect method for Soft and Bridge Tooling, Future Directions of AM: Introduction, new types of products and employment. A Rapid prototyping case study based on experimental development of FFF components as a mini project. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific, 2010.
2. Jacobs, PF (Ed), Rapid Prototyping and Manufacturing, Society of Manuf. Engrs.
3. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer, 2010.
4. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
5. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Course Outcomes

CO 1: To comprehend various types of rapid prototyping techniques
CO 2: To apply various designing and slicing techniques that enables 3D printing and creates programming for tool path.
CO 3: To comprehend the product development cycle, RT processes and reverse engineering solutions
CO 4: To create RP components by applying fundamental knowledge of different process.

MEPE306: WORK STUDY AND ERGONOMICS

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:
Work study and ergonomics is a subject in Mechanical Engineering that focuses on applying the concepts of techniques like method study and work measurement to understand human work potential in terms of time spend for completing a task, looking at ways to make the task simpler and easy so as to increase productivity and efficiency. Work study is used for finding ways of increasing job performance, optimizing usage of plant and machinery and standardization of work methods. Ergonomics is complementary to work study and aids in designing or arranging workplaces, products and systems so that they best fit the people who use them.

UNIT- I

Productivity and Work-Study: Productivity: Concept and definition, Difference between production and productivity, Reasons for low productivity, factors influencing productivity, productivity measures, productivity measurement models, methods/techniques to improve productivity, Work content, Numerical Problems.
Work-Study: Definition, Historical development of work study, objective and scope of work study. Human factor in work study, Work study and management, work study and supervisor, work study and worker, qualities of work-study man **(8 hrs**)

UNIT- II

Method-Study: Definition, objectives, step-by-step procedure, selection of job for method study, questioning techniques, charts and diagrams for recording data: outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart, models and templates, cycle graph, Chrono-cycle graph, Therbligs, Micro motion study and film analysis, Memo-motion study, SIMO chart, Principles of motion economy, development and installation of new methods. Numerical problems and Case studies

(10 hrs)

UNIT- III

Work–Measurement: Introduction & definition, various techniques of work-measurement, objectives and basic procedure of work measurement; application of work measurement in industries; time study: basic procedure, equipment needed, methods of measuring time, selection of jobs, breaking a job into elements; numbers of cycles to be timed; rating and methods of rating, allowances, work sampling, normal time, standard time, numerical problems, Predetermined Motion Time System and its types, Work Factor System, Method Time Measurement and Basic Motion Time, MOST, calculation of standard time, Numerical problems and case studies. **(10 hrs)**

UNIT- IV

Ergonomics: Introduction, history of development, objectives, applications of ergonomics, related sciences of ergonomics, man-machine system and its components, design of Man Machine Systems, characteristics of man machine system, man versus machines, Aspects of man machine system: design of information/visual displays, design of controls, Design of work posture, environmental factors and working conditions: effect of vibration, noise, temperature and illumination on performance. Applied Anthropometry - types, use, principles and applications, design of work place and seat design, Significance of Ergonomics in industry 4.0, Case study: Ergonomic design consideration for designing office chair.
Design of lifting tasks using NIOSH lifting equation, Distal upper extremities risk factors, risk assessment tools; Strain Index, RULA, REBA. **(12 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books:

1. Barnes Ralph M., Motion & Time study: Design and Measurement of Work, Wiley Text Books, ed. 7th, 2001.
2. Marvin E, Mundel & David L, Motion & Time Study: Improving Productivity, Pearson Education, 2000.
3. Benjamin E Niebel and Freivalds Andris, Methods Standards & Work Design, McGraw Hill, 2013.
4. International Labour organization, Work-study, Oxford and IBH publishing company Pvt. Ltd., New Delhi, 2001.
5. Sanders Mark S and McCormick Ernert J, Human Factors in Engineering and Design, McGraw-Hill Inc., 1993.
6. Sharma S K and Sharma Savita, "Work Study and Ergonomics", S K Kataria & Sons., Delhi, 2014.
7. Dr. P.C. Tewari, "Work Study and Ergonomics",CRC Press U.K.. 2018
8. Lakhwinder Pal Singh, "Work Study and Ergonomics", Cambridge University Press. 2016
9. R.S.Bridger -Introduction to Ergonomics, Taylor and Francis, 2003

Course Outcomes:

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

CO 1: Understand the productivity and Work Study concepts and their applications

CO 2: Demonstrate the tools and techniques of method study

CO 3: Determine standard time of a job using the various techniques of work measurement

CO 4: Understand the prime concepts of Ergonomics and its significance in relation to the design of work place and controls etc.

MEPE307: ADVANCED WELDING TECHNOLOGY

Pre-requisite: Manufacturing Processes, Workshop Practice

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

Advanced Welding Technology is a subject in mechanical engineering that focuses on the study and application of advanced welding processes, techniques, and materials. It aims to provide students with an in-depth understanding of the latest developments in welding technology and equip them with the skills necessary to tackle complex welding challenges in industrial settings. Students will develop the skills necessary to select appropriate welding processes, optimize welding parameters, ensure weld quality, and address challenges associated with advanced materials and applications. This knowledge prepares them for roles in industries where welding plays a crucial role, such as automotive, aerospace, construction, and energy sectors.

UNIT - I

Arc physics, volt-ampere (VI) characteristics, duty cycle, AC/DC, CC and CV power sources, metal transfer modes in welding, residual stresses, heat flow and welding metallurgy, weldability of SS and Ni-base alloys. **(10 hrs)**

UNIT-II

High-energy density welding processes: concept, mechanism and applications of high density welding processes; plasma arc welding, laser beam welding; fundamentals, types of lasers, electron beam welding and its recent developments. **(10 hrs)**

UNIT - III

Solid state welding processes; friction stir welding, ultrasonic welding, diffusion bonding, Non-conventional welding; underwater welding, microwave hybrid joining, adhesive weld bonding, magnetic impelled arc butt welding(MIAB). **(10 hrs)**

UNIT – IV

Advanced tungsten inert gas welding: high frequency pulsed GTAW, cold and hot wire feeds, multi-cathode GTAW, Pulse & Synergic-MIG, cold-metal transfer (CMT) welding, narrow-groove welding techniques; joint preparation, narrow gap GTAW torch, sustainable practices in advanced welding like hot wire laser welding, case study of pressure vessels welding – dissimilar welding, thick section NG welding. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Hoffman. D.J., Welding, 2nd Ed., Pearson.
2. Little, R.L., Welding and Welding Technology, McGraw-Hill.
3. Norrish, J., Advanced Welding Processes, Woodhead Publishing.
4. Misra, R., Friction Stir Welding and Processing: Science and Engineering, Springer.
5. AWS Welding Handbooks, 9th Edition, Vol. 1 & 3, AWS Publications.
6. Kou, S., Welding Metallurgy, Wiley-Interscience.
7. Parmar, R.S., Welding Engineering and Technology, Khanna Publishers.
8. Nadkari, S. V., Modern Arc Welding Technology, 2nd edi. (2005), Oxford & India Book House Pvt. Ltd.
9. Robert W. Messler, Jr., Principles of Welding – Processes, Physics, Chemistry, and Metallurgy, (2014 reprint) Wiley-UCH Publisher

Course Outcomes

CO 1: Students will select and demonstrate appropriate use of power sources for given welding conditions.

CO 2: Students will understand and identify the nature of residual stresses during welding.

CO 3: Students will select and design the thick section welding using various welding techniques and processes.

CO 4: Students will interpret and apply the knowledge of conventional and advanced welding processes for the present engineering and fabrication scenario.

MEPE308: THERMAL POWER ENGINEERING

Pre-requisite: Thermodynamics, Fluid machines

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

The course on Thermal Power Engineering course offers a straightforward comprehension of the subject matter. It covers various aspects, such as the basic steam power cycle, including reheat, regeneration, and superheating. Additionally, it delves into actual cycles with component efficiencies and provides detailed discussions on each component of the power plant. The course also includes comprehensive studies on gas and diesel thermal power plants. Furthermore, it addresses the economic and environmental aspects of power generation.

UNIT-I

Introduction: Introduction to thermal power, Description and classification of boilers, Boiler mountings & accessories, Natural draught, Artificial draught: Chimney design, Steam jet draught and mechanical draught, Calculation of boiler efficiency & equivalent evaporation.

Vapour Power Cycles: Carnot cycle, Simple & modified Rankine cycles, Effect of operating variables on Rankine cycle, Rankine cycle with superheating, Reheating & regeneration, Reheat factor, Binary vapour cycle**.** **(10 hrs)**

UNIT-II

Steam Turbines: Introduction, Classification of steam turbines, Working principle, Compounding, Velocity diagrams, Calculation of power output and efficiency, Condition for maximum efficiency, Degree of reaction, Governing of steam turbine.

Steam (Thermal) Power Plants: Analysis of steam power cycles for power plant application; High pressure boilers- La-Mont boiler, Benson boiler, Loeffler boiler; Velox boiler; Super pressure steam power plants; Economizers; Air-preheaters; Super heaters and reheaters; Feed water heaters. General layout of thermal power plant; Site selection for thermal power plant; Coal as fuel, classification of coals, analysis of coal; Coal handling; Dead and live storage; Combustion of coal: coal burning methods, overfeed stokers, underfeed stokers, Pulverized fuels and burners. Ash handling and disposal; Dust collectors. Heat balance sheet for thermal power plants. **(16 hrs)**

UNIT-III

Diesel Power Plants; Introduction; Field of use; Outline of diesel electric power plant; Different systems of diesel power plant; Supercharging of diesel engines; Performance of diesel power plant; Advantages and disadvantages of diesel plants over thermal power plants

Gas Turbine Plants: Elements of plant; Thermal refinements; Performance of plants; Gas turbine characteristics; Comparison with other plants; Combined steam and gas turbine power plants. **(8 hrs)**

UNIT-IV

Economics of Power Generation: Introduction, Load curves, Different terms and definitions, Effects of variable loads on power plant design and operation. Cost of electrical energy; performance and operating characteristics of power plants; Load division among generators; Case studies/Latest developments/Sustainable technologies in Thermal Power Engineering. **(6 hrs)**

NOTE:

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Text Books/References:

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1. Power plant Engineering by Black & Veatch, CBS Publisher, 2005
2. Power plant Engineering by P K Nag, TMH
3. Thermal Engineering by Ballaney, Khanna Publisher
4. Steam Turbine Theory & Practice by Kearton, W.J. Pitman.
5. Power Plant Engineering by Morse
6. Power Plant Technology by El-Wakil

Course Outcomes:

CO1: Understand the over view of boilers and power plant cycles.
CO2: Understand the operations of steam turbines and steam power plants.
CO3: Analyze the operations of diesel and gas turbine power plants.
CO4: Rectify the general challenges in thermal power plants

MEPE309: NUCLEAR ENGINEERING

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	-	-	3	40

1. **Concepts of Nuclear Physics**
   The atom, structure, the nucleus, nuclear structure, atomic transmutation of elements, detection of radio-activity, particle accelerator, decay, natural of elements, nucleus interactions, decay rates, half-life, transuranic elements.
   (6hrs)
2. **Neutorn Interaction**
   Advantages of using neutron, neutron moderation, fission chain reaction, thermalisation of neutrons, fast neutrons, prompt and delayed neutrons, fission products. **(4hrs)**
3. **Energy Release**
   Mass energy equivalence, mass defect, binding energy, energy release in fission & fusion, thermonuclear reaction, fusion bomb. **(4hrs)**
4. **Reactor Materials**
   Fissile & fertile materials, cladding & shielding materials, moderators, coolants.
   (4hrs)
5. **Reactor Technology**
   Basic principles, fuel assembly, neutron balance, reactor kinetics, reactor coefficients, reactor stability, excess reactivity, Xenon poisoning, burnable absorbers, reactivity control, heat balance, production& transfer of heat to the coolant, structural considerations. **(10 hrs)**
6. **Nuclear Reactors**
   Types of nuclear reactors, pressurized water reactors, boiling water reactors, CANDU type reactors, gas cooled & liquid metal cooled reactors, fast breeder reactors. **(6hrs)**
7. **Safety Considerations & Waste Disposal**
   Hazards, plant site selection, safety measures incorporated in; plant design, accident control, disposal of nuclear waste. **(4hrs)**
8. **Health Physics & Radio-isotopes**
   Radiation: units, hazards, prevention, preparation of radio-isotopes& their use in medicine, agriculture & industry. **(2hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. M. M. El-Wakel, Nuclear Power Engineering, McGraw Hill
2. Shultis and Faw, Fundamentals of Nuclear Science and Engineering, CRC Press
3. Stephenson, Introduction to Nuclear Engineering, McGraw Hill
4. Murray, Nuclear Energy, Butterworth-Heinemann.

Course Outcomes:

CO1: To understand the concepts of neutron physics and various nuclear Processes involved in Nuclear Power Plants.
CO2: To calculate heat generation from nuclear reaction.
CO3: To design and analyze the performance of nuclear power plants.
CO4: To get acquainted with applications of radioactivity.
CO5: To appreciate the hazards associated with radioactivity and the necessity of waste disposal.

MEPE310: COMPUTATIONAL FLUID DYNAMICS

Pre-requisite: Fluid Machanics

L	T	P	Credits	Total contact hours
3	0	0	3	40

1. Introduction: Introduction to C.F.D., models of flow, governing differential equations – continuity equation, momentum equation, energy equation, Navier- Stokes equation, physical boundary conditions. **(5 hrs)**

2. Mathematical behaviour of governing equation: Classification of quasi linear partial differential equation, General method of determining the Classification of partial differential equation, hyperbolic, parabolic, elliptic equations. **(5 hrs)**

3. Discretization methods: Finite difference methods, difference equations, explicit & implicit approach, errors & analysis of stability. Basics of finite control volume method **(5 hrs)**

4. Heat conduction problem: Solution of One dimensional heat conduction through a fin, solution of two dimensional steady state and transient heat conduction problems, heat conduction problems in cylindrical coordinates: axisymmetric and non-axisymmetric problems. **(7 hrs)**

5. Heat conduction with convection & diffusion: Steady state one dimensional convection and diffusion, upwinding, exact solution, exponential scheme, hybrid scheme, power law scheme, Discretization equation for two dimensions & three dimensions, false diffusion **(8 hrs)**

6. Fluid flow problem: Viscous incompressible flow, solution of the couette flow problem by F.D.M., calculation of the flow field using stream function – vorticity method, numerical algorithms for solving complete Navier-Stokes equation – MAC method; SIMPLE method. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. Suhas. V. Patankar, Numerical heat transfer and fluid flow, Hemisphere.
2. John. D. Anderson, Jr, Computational fluid dynamics, McGraw Hill.
3. Vesrteeg and Malalsekera, An Introduction to Computational fluid dynamics- The Finite Volume Method, Longman Scientific and Technical.
4. Anil .W. Date, Introduction to Computational fluid dynamics, Cambridge University Press.
5. Niyogi, Chakraborty and Laha, Introduction to Computational fluid dynamics, Pearson Education.

Course Outcomes:

CO1: To understand the concepts of PDEs and apply them to CFD problems.
CO2: To understand discretization and its application to problems.
CO3: To solve problems related to heat transfer and fluid flow using Finite Difference and Finite Volume Methods.
CO4: To understand the limitations and errors involved in solution to CFD problems.

MEPE311: RENEWABLE ENERGY SYSTEMS

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

The main purpose of this course is to introduce students with conventional and Renewable energy sources environmental impacts, challenges and future trends, fundamentals, potential, estimation and, applications: Solar Energy, Wind Energy, Hydropower, Biomass, Geothermal Energy, Ocean Energy. The Renewable energy resources availability, potential and suitability as a substitute for conventional energy resources in future energy demand. Having completed the courses, the student should have Knowledge about different renewable energy resources. Advanced knowledge about potential of using renewable energy technologies as a complement to and to the extent possible, replacement for conventional technologies, and possibilities to combining renewable and non-renewable energy technologies in hybrid systems.

UNIT - I

Forms of Energy, Nuclear energy, Hydro energy, Renewable energy, Energy demand, Energy statistics, Comparison of fuels such as wood, charcoal, coal, kerosene, Diesel, petrol, furnace oil, LPG, biogas and electricity on calorific value and cost basis, Efficiencies of various Energy production methods. Ministry of Power, Ministry of New and Renewable Energy, Energy Auditing and Management, Energy Conservation Act, Bureau of Energy Efficiency, Schemes and policies of PCRA. **(08 hrs)**

UNIT – II

Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications. Solar Collectors, Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Flat-plate collectors: types; Thermal analysis; Thermal drying. Selective surfaces - Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization. **(10 hrs)**

UNIT – III

Energy Generation from wastes: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments – types of digesters –factors affecting bio-digestion - Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in municipality and medical. **(12 hrs)**

UNIT – IV

Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. – Site Selection Criteria – Advantages – Limitations – Wind Rose Diagram – Indian Wind Energy Data – Organizations like C-WET etc., Wind Energy Conversion System - Design - Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction. **(10 hrs)**

Text Books / References:

1. Renewable Energy Sources by Twidell & Weir, Taylor and Francis, 2nd Special Indian Edition.
2. Non-conventional Energy Sources by G.D. Rai, Dhanpat Ral and Sons.
3. Renewable Energy Resources by Tiwari and Ghosal, Narosa.

Course Outcomes:

CO 1: Understanding of commercial energy and renewable energy sources.
CO 2: Knowledge in working principle of various energy systems.
CO 3: Capability to do basic design of renewable energy systems.
CO 4: Upon completion of this course, the students will be able to identify the new Methodologies / technologies for effective utilization of renewable energy sources.

MEPC315: MACHINE DESIGN – II

Pre-requisite: Machine Design- I

L	T	P	Credits	Total contact hours
2	0	5	4	94

Brief Description about the course:

This course is designed for B.Tech students to develop their understanding about the designing of i) Power transmission elements like Design of different types of gears, belt drives, ii) Design of Brakes, Design of Clutches, Design of Springs iii) Design of Rolling Contact Bearings; Lubrication and Journal Bearings, design of Crane hook iv) Design of IC engine parts like cylinder, piston, crankshaft, connecting rod and valve gear mechanism for I.C. Engine, Design of Cam and Follower Mechanism, design of Flywheel. Following will be course learning objectives.

1. To understand the design process of different types of gears, gear box, different types of belt drives, chain drive, rope drive and their applications in industry.
2. To understand the utility and design process of different types of cluches, brakes and springs used in automotive industry.
3. To understand the process of design for various types of bearings and crane hook.
4. To understand the design process of I.C. engine components like cylinder, piston, crankshaft, connecting rod, valve gear mechanism and flywheels.

UNIT-I

Design of Gears: Design of spur, helical, bevel and worm gears, gear box design including housing.

Design of belt drives: Design of flat and V - belt, chain drive, Wire ropes and Sheaves. **(24 hrs)**

UNIT-II

Design of Brakes and clutches: Design of brakes, Energy absorbed by brake, Heat dissipation during braking, External and internal shoe type and disk type.Design of single and multiple plate and cone clutches, centrifugal clutch

Design of Springs: Types of Springs, Spring Materials, Design against fluctuating load, Surge in springs, Design of Helical, Spiral, Multileaf, Belleville, Rubber Springs **(24 hrs)**

UNIT-III

Design of Bearings: Selection of bearings, Static and dynamic load carrying capacity, Design for cyclic loads and speeds, Bearing failure, Selection and design of rolling contact bearings, Reynold's Equatio, Raimondi & Boyd Metod, bearing materials, Design of various hydro-dynamically lubricated bearings, bearing failures.

Design of Crane hook: Types of Crane hooks, Hook Materials, Design of Crane hook

Design of Cam and Follower Mechanism: Types of Cams and Followers, materials for Cam & follower system, Design of Various types of Cams **(22 hrs)**

UNIT-IV

Design of I C Engine Parts: Design of cylinder, piston, crankshaft, connecting rod and valve gear mechanism for I.C. Engine.

Design of flywheels: Concept of Flywheel, Maximum fluctuation of Energy, Coefficient of fluctuation of speed, Design of Flywheel rim, arms, hub, shaft, key. Stresses in flywheel rim and arms. **(24 hrs)**

Case study 1: Design and analysis of Automatic Self Folding Dining Table.
Case study 2: Design and analysis of 360° Welding Cutting Rotary Turn Table Positioner.
Case study 3: Design and analysis of Regenerative Braking System.
Case study 4: Design and analysis of 3 DOF Hydraulic Extractor Mini JCB.
Case study 5: Design and analysis of Automated 5D of Robotic Arm Mechanism.
Case study 6: Design and analysis of Pulley Based Movable Crane Robot.
Case study 7: Design and analysis of Mini Conveyor Belt Mechanism.
Note: Prepare the drawing sheets for above problems based on your calculated dimensions.

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books

1. Design of Machine Elements by Bhandari, Tata McGraw-Hill
2. Machine Design by Maleev and Hartmann, CBS Public.
3. Machine Design by Sharma and Aggarwal, Kaston Publc.
4. PSG Design data book by PSG Publication, Coimbtore
5. Machine Design – An Integrated Approach by Robert L. Norton, Prentice-Hall Inc.
6. Fundamentals of Machine Component Design by R.C. Juvinall, John Wiley & Sons
7. Machine design data book by V.B.Bhandari

Course Outcomes

At the end of the course student will be able to

CO1: Understand the design process of different types of gears, gear box, different types of belt drives, chain drive, rope drive and their applications in industry.

CO2: Understand the utility and design process of different types of cluches, brakes and springs used in automotive industry.

CO3: Understand the process of design for various types of bearings and crane hook.

CO4: Understand the design process of I.C. engine components like cylinder, piston, crankshaft, connecting rod, valve gear mechanism and flywheels.

MEPC316: REFRIGERATION AND AIR CONDITIONING

Pre-requisite: Heat Transfer

L	T	P	Credits	Total contact hours
3	-	-	3	40

Brief description about the course

This Course provides a simple understanding of Refrigeration and Air-conditioning fundamentals. Ideally suited to those with a little or no knowledge of the subject. The course consists of different refrigeration cycles and understanding of psychrometry and psychrometric processes used for the purpose of air-conditioning. Further, the comfort air-conditioning and indoor environment health are also addressed in this course.

UNIT-I

Introduction: A Refrigerating Machine—The Second Law Interpretation, Heat Engine, Heat Pump and Refrigerating Machine, units of refrigeration, Energy Ratios or Coefficients of Performance, Heat Pump vs. Electric Resistance Heater, Best Refrigeration Cycle: The Carnot Principle, Reversed Carnot Cycle, Effect of Operating Temperatures, Selection of Operating Temperatures, Problem Solving, Vapour as a Refrigerant in Reversed Carnot Cycle, Limitations of Reversed Carnot Cycle.

Air Refrigeration: Limitations of Carnot Cycle with Gas as a Refrigerant, Reversed Brayton or Joule or Bell Coleman Cycle, Analysis of Gas Cycle, Application to Aircraft Refrigeration, Simple Aircraft Refrigeration Cycle with Ram Compression, Problem Solving, Dry Air Rated Temperature, Air-cycle Systems for Aircraft Refrigeration: Simple System & Bootstrap system, Problem Solving, The Joule–Thomson Coefficient and Inversion Curve. **(8 hrs)**

UNIT-II

Vapour Compression System: Work in Reciprocating Compressor, Modifications in Reversed Carnot Cycle with Vapour as a Refrigerant, Dry Versus Wet Compression, Throttling Versus Isentropic Expansion,

Vapour Compression Cycle, P-h Charts, Vapour Compression System Calculations, Ewing's Construction, Standard Rating Cycle and Effect of Operating Conditions, Depiction of actual refrigeration cycle on T S & P-h.

Multi-Pressure Systems: Introduction, Multistage or Compound Compression, Flash Gas Removal, Flash Intercooling, Choice of Intermediate Pressure, Complete Multistage Compression System, Problem Solving, Multi-Evaporator Systems, Cascade Systems, Solid Carbon Dioxide—Dry Ice

Refrigerants, Nomenclature/designation of refrigerants, selections, Thermodynamic requirements, chemical requirements, physical requirements, Environmental impact of refrigerants,

Vapour Absorption Systems: Faraday's Experiment, Simple vapour Absorption refrigeration system, comparison between absorption and vapour compression systems, Ammonia water system, lithium bromide, Problem Solving, Thermodynamic requirements of Mixtures Refrigerant – Absorbent pair characteristics: Electro-Lux refrigerator, Problem Solving.

(13 hrs)

UNIT-III

Properties of Moist Air: Psychrometric Properties of moist air, Specific Humidity or Humidity Ratio, Dew Point Temperature, Problem Solving, Degree of Saturation, Relative Humidity,, Enthalpy of Moist Air, Humid Specific Heat, Problem Solving, Wet Bulb Temperature, Thermodynamic Wet Bulb Temperature or Temperature of Adiabatic Saturation, Psychrometric Chart, Application of First Law of thermodynamics to a Psychrometric Process, Problem Solving,

Psychrometry of Air-Conditioning Processes:Mixing Process, Problem Solving, Basic Processes in Conditioning of Air: Sensible heating, Sensible cooling, Humidifying, Dehumidifying, Heating, and humidifying, Cooling, and dehumidifying, Cooling, and

humidifying, Heating, and dehumidifying, Psychrometric Processes in Air-Conditioning Equipment, Bypass Factor, Heating Coils, Air Washer, Adiabatic Dehumidifier, Water Injection, Steam Injection, Problem Solving, Summer Air Conditioning, Winter Air Conditioning.

(8 hrs)

UNIT-IV

Design Conditions: Choice of Inside Outside Design Conditions, Outside Design Conditions, Cold storage, Industrial air conditioning. Comfort Air Conditioning and Effective Temperature, Comfort, The Metabolic Rate, Mechanism of Body Heat Loss, Mathematical Model of Heat Exchange between Man and Environment, Purposes of Ventilation, Air Filters

Load Calculations and Applied Psychometric: Preliminary Considerations, Internal Heat Gains, System Heat Gains, Break-up of ventilation load and effective sensible heat factor, Cooling load estimate, Heating Load Estimate, Psychometric calculations for cooling, Selections of air conditioning apparatus for cooling and dehumidification, Evaporative cooling, building requirement and energy conservation in air conditioning buildings. **(11 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / References:

1. Refrigeration & Air-conditioning, CP Arora, TMG
2. NPTEL Video Course Refrigeration and air-conditioning, Dr. Ravi Kumar is a Professor in the Department of Mechanical & Industrial Engineering, Indian Institute of Technology Roorkee
3. Refrigeration & Air-conditioning, Manohar Prasad, NAI
4. Refrigeration & Air-conditioning, Stoecker & Jons, MGH
5. Principles of Refrigeration, RC Dosset, LPE
6. ASHRAE Handbook (Fundamentals), ASHRAE

Course Outcomes:

CO 1: Students should be able to understand the need and importance of various refrigeration and air conditioning cycles, the typical and some advanced and innovative schematic designs, and the goals of R&AC systems.

CO 2: Students should be able to design the VCRS and VARS with improving performance parameters.

CO 3: Students should be able to describe the working of different types of air conditioning systems.

CO 4: Student should be able to understand the actual applications of RAC.

MEPC327: REFRIGERATION AND AIR CONDITIONING (P)

Pre-requisite: HT (P)

L	T	P	Credits	Total contact hours
-	-	2	1	24

Brief description about the course

This Course provides a simple understanding of Refrigeration and Air-conditioning fundamentals. The course consists of different refrigeration cycles and understanding of psychrometry and psychrometric processes used for the purpose of air-conditioning. Further, the comfort air-conditioning.

Course Contents:

1. To study the performance of vapour Compression refrigeration cycle
2. To study various components of room air conditioner.
3. To study three fluid vapour Absorption refrigeration system and find out its theoretical & actual COP.
4. To Study different refrigerant control and electric control devices of a refrigeration system.
5. Study and Performance of ice plant test rig.
6. To find the theoretical & experimental C.O.P. of the system, when using as refrigerator and as heat pump by reversing the cycle and show that $(COP)_{HP} = (COP)_R + 1$.
7. To Study the heat balance sheet on the computerised recirculating type air conditioning test rig.
8. To study humidification with heating & dehumidification with cooling.
9. To study the constructional details of hermetically sealed reciprocating compressor & rotary compressor.
10. To Study the performance of Solar-assisted heat pump

Course Outcomes:

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

CO1: Study of refrigerant compressors, expansion devices used in vapour compression refrigeration system, thermostat with range and differential setting, charging of refrigeration system.

CO2: Trial on pilot ice plant to evaluate cycle performance and actual coefficient of performance.

CO3: Participate in a group atmosphere for the understanding of an industrial refrigeration system.

CO4: Communicate effectively both verbally and in written form through the preparation of journal report and practical presentation.

MEPE317: LOGISTICS & SUPPLY CHAIN MANAGEMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
03	00	00	03	40

Brief Description about the course

To understand concept of Supply chain management and apply this knowledge to understand the working of corporate world.

Unit-I

Understanding the Supply Chain, Performance, Drivers and Obstacles: Objectives of supply chain, Stages of supply chain, Supply chain process cycles, Push/pull view of supply chain processes, Importance of supply chain flows, Examples of supply chain, Strategic decisions in supply chain management. Supply Chain Performance, Supply chain strategies, achieving strategic fit, Product life cycle, Supply Chain drivers and Obstacles, four drivers of supply chain – inventory, transportation, facilities, and information, Obstacles to achieve strategic fit.

(10 hrs)

Unit-II

Planning Demand and Supply in a Supply Chain: Role of forecasting in a supply chain, Forecasting methods in a supply chain, Basic approach to demand forecasting, Aggregate planning resources. Managing economies of scale in a supply chain, Role of cycle inventory in a supply chain. **(10 hrs)**

Unit-III

Transportation and Coordination in a Supply Chain: Facilities affecting transportation decisions, Transport selection, Modes of transportation and their performance characteristics, Trade-offs in transportation decision, Making transportation decisions in practice, Models for transportation and distribution, Third party logistics (3PL). Coordination in a Supply chain, Lack of supply chain coordination and the Bullwhip effect, Effect of lack of coordination on performance, Obstacles to coordination, Achieving coordination in practice. **(10 hrs)**

Unit-IV

Source Management and IT in Supply Chain: Inventory management in supply chain, Information technology in supply chain, Typical IT solution, Reverse supply chain, Reverse supply chain Vs. Forward supply chain

Advanced topics in SCM: Green, Lean, Sustainable, Global and Agile supply chain Management, Quality in Supply Chain. Integration and Collaborative Supply Chain, Circular Supply Chain Management.

Cases in Supply Chain: Case Studies such as Newspaper, Mumbai Tiffanwala, Disaster Management, Organic Food, Fast Food, Hostel Mess etc. **(10 hrs)**

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Text/Reference Books:

1. Christopher Martin, "*Logistics and Supply Chain Management*", Pearson Education Asia.
2. Chopra Sunil and Meindl Peter, "*Supply Chain Management – Strategy, planning and operation's"*, Pearson Education, Asia.
3. Kapoor K K, KansalPurva, "*Marketing logistics: A Supply Chain Approach*", Pearson Education Asia.
4. Mohanty, R.P and Deshmukh, S.G., "*Supply Chain Management*", Pearson Education Asia.
5. Fawcett, S. E., Ellram, L. M and Ogden, J. A., "Supply Chain Management" Pearson Education Asia.
6. Dixit Garg, Sunil Luthra and Sachin Mangla., "Supply Chain and Logistics Management". New Age International Publishers

Course Outcomes:

CO 1: Understand the decision phases and apply competitive & supply chain strategies.
CO 2: Understand drivers of supply chain performance.
CO 3:. Analyze factors influencing network design and forecasting in a supply chain.
CO 4: Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

MEPE318: OPERATION RESEARCH

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	41

Brief Description about the course

Operation research uses Mathematical techniques to model, analyze and solve the problem today's business has to face a large number of constraints. The operation research techniques can help the executive's to express business constraints into measurable terms. A number of operation research techniques that provide the scientific basis to generate the alternatives and select the optimum solution are covered

UNIT- I

Introduction: Development of Operation Research, Characteristics and Scope of Operation Research in management, Models in operation research, Model formulation, Types of Mathematical models, Limitation of operation research

Linear programming**:** Introduction, Terminology, Advantages, Limitations and applications of linear programming, Illustrative problems on formulation of linear programming model, Graphical Method of solution, Simplex method, Artificial variable technique for solving the Initial basic feasible solution (Big M-Method), essence of duality theorem , Sensitivity analysis **(10 hrs)**

Unit – II

Transportation Model: Introduction to transportation Problems, Mathematical model for Transportation Problem, Methods for initial basic solution: Northwest corner method, Least cost method, ROW Minima Method, Column Minima Method, Vogel's approximation method, Degeneracy in transportation, Optimal solution using Modified Distribution Method, Special cases- Unbalanced problems and profit maximization problems

Assignment Model: Introduction to Assignment, Mathematical formulation of the assignment problem, Hungarian Method **(10 hrs)**

Unit - III

Sequencing Models: Sequencing Problems, Processing n jobs through two Machines, Processing n jobs through three Machines, Processing two jobs through m Machines, Processing n jobs through m Machines, The Travelling salesman Problem

Simulation: Introduction, Monte Carlo Simulation, Random Numbers, Procedure for Monte Carlo Simulation, Advantages of Simulation, Industrial Application of Simulation **(10 hrs)**

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Unit – IV

Decision and Game theory: Introduction, Steps in Decision Theory approach, Decision making Environments, decision Making under condition of Certainty, Decision Making under condition of Uncertainty, Decision Making under condition of Risk, Decision Trees, Theory of games, Competitive games, Terminology, Rules for Game Theory , Two person zero sum game, Solution of 2*2 game with no saddle point, Dominance in Games, Sub-game Method to solve (2*n or m*2) Mixed strategy games, Graphical Method to solve (2*n or m*2) games, mixed strategy (3*3) games

PERT AND CPM: Introduction, Objectives of PERT and CPM, Terms related with PERT and CPM, Rules for Network Construction, Numbering of Events(Fulkerson's Rule), Frequency distribution Curve for PERT,PERT Computations, slack, Critical Path, Probability of meeting the scheduled dates, CPM, terms, Critical Path, Float, Cost Analysis, Contracting and Updating **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference books

1. P.K.Gupta and D.S.Hira “Operation Research ,S.Chand Co. 2007
2. Manohar Mahajan ”Operation Research” Dhanpat Rai &Co.(Pvt.) Ltd.
3. P.Sankara Iyer, “Operation Research” Tata McGraw-Hill,2008
4. J.K.Sharma, ”Operation Research, Problems and Solutons,3e”, MacMillan India Ltd.

Course Outcomes

CO1 : The students will be able to formulate real world problems as Mathematical model and solve Linear Programming problems
CO2 : Student will be able to formulate and solve transportation and Assignment problems
CO3 : The student will be able to solve sequencing problem and perform Simulation
CO4 : The student will be able to solve game theory and Decision theory problems
CO5 : The students will be able to formulate and solve scheduling problem

MEPE319: RELIABILITY AND MAINTENANCE ENGINEERING

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course will be useful in developing student's skill related to current maintenance practices and advanced maintenance issues handling in small and heavy process industries. The course imparts the theoretical and analytical skill based knowledge about maintenance practices in different Industries/plants. Various reliability based maintenance models with their industrial application are also covered under this course.

UNIT - I

Reliability based maintenance engineering: Introduction to Probability concepts, RAM aspects in maintenance, Failure Distribution- Reliability function, CDF and PDF, hazard rate function, Bath tub curve for industrial repairable system, conditional reliability concept in maintenance, Exponential, Weibull, normal and lognormal distributions based maintenance models. System reliability determination: Series –parallel system reliability, Type of redundancy, k out of n standby system, redundant standby systems, system structure functions, minimal cuts and minimal paths.

State- Dependent system- Markov analysis for system availability: load sharing system, stands by systems, degraded systems **(10 hrs)**

UNIT – II

Maintenance introduction and overview: Maintenance definition, objectives and importance of maintenance, functions of maintenance: basic functions and composite functions, primary and secondary functions.

Maintenance strategies: Definition of maintenance strategy, Classification of maintenance strategies, other maintenance strategies, advantages and disadvantages of maintenance strategies.

Total Productive Maintenance: TPM Definition, Principles, TPM VIS-A-VIS Terro-Technology, Pillars of TPM, TPM implementation in industry. **(10 hrs)**

UNIT – III

Maintenance Planning and scheduling: Maintenance planning and scheduling types and techniques, short and long term planning.

Condition monitoring: Condition signals and monitoring, condition monitoring techniques: Performance monitoring, temperature monitoring, thermography, leakage monitoring, vibration monitoring, lubricant monitoring, ultrasound monitoring, corrosion monitoring, Motor current signature analysis (MCSA).

Maintenance Effectiveness, indices and audit: OEE, Equipment availability, maintenance effectiveness assessment, KPI, maintenance performance measuring indices.

(10 hrs)

UNIT – IV

Case Studies with Application: Application of RCA, FMEA and FMECA tools for industrial maintenance, Design of fuzzy MATLAB tool box based FMEA decision support system for maintenance action, Fault tree and PN diagram based availability analysis, Maintenance decision making models with industrial application. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Kelly A., “Maintenance Planning and Control”, Butterworth-Heinemann.Ltd, London.
2. Cliffton R. H.,“Principle of Planned Maintenance”, McGraw Hill Inc. New York
3. Charles E. E., “An Introduction to Reliability and Maintainability Engineering”, McGraw Hill Education,New York, 2017.
4. Dhillon B S, “Engineering Maintainability”, Prentice Hall of India, New Delhi, 2000.
5. Wireman Terry, “Preventive Maintenance”, Reston Publishing Company, Reston Virginia, 1998

Course Outcomes

CO 1: Student will be able to learn various reliability concepts and its implementation in industry.

CO2: Students will be able to develop reliability based mathematical modeling for industrial system.

CO 3: Students will gain knowledge related to maintenance objective/functions and TPM.

CO 4: Students will be able to learn how to plan & schedule the maintenance job.

CO 5: Students will learn about various CM techniques and their implementation.

CO 6: Students will become capable to implement various maintenance tools in industry.

MEPE320: ADVANCED MANUFACTURING PROCESSES

Pre-requisite: PT-II

L	T	P	Credits	Total contact hours
03	--	--	03	40

Brief description about the course:

This course provides students with an understanding of advanced manufacturing technology and skills relating to the implementation of these technologies in modern industry within both global and local contexts. Topics include basics of advanced machining processes, advanced casting and welding methods, advanced metal forming processes, etc.

UNIT-I

Advanced Machining Processes: Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of advanced manufacturing processes such as; ultrasonic machining, Abrasive jet machining, Water jet machining, Abrasive water jet machining, Electrochemical machining, Electro discharge machining, Electron beam machining, Laser beam machining processes, principle of Plasma arc machining. **(12 hrs)**

UNIT-II

Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting.

Advanced Welding Processes: Details of electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW). **(08 hrs)**

UNIT-III

Advanced Metal Forming Processes: Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming Electro-hydraulic forming, Stretch forming, Contour roll forming.

Analysis of Metal Forming Processes: Theoretical basis of metal forming, classification of metal forming processes, cold forming, hot working, Warm working, Effect of variables on metal forming processes, Methods of analysis of manufacturing processes, Open Die forging, Rolling Power Rolling, Drawing, Extrusion. **(10 hrs**)

Special Processing Technologies: Rapid Prototyping - Methods - Fused Deposition Modeling (FDM) - Laminated Object Manufacturing (LOM) - Selective laser sintering (SLA) - Solid Ground curing (SGC) - 3D printing (3DP) - Processing of integrated circuits - Micro and nano fabrication technologies. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text/Reference Books:

1. Abdel, H. and El-Hofy, G. “Advanced Machining Processes”, McGraw-Hill, USA, 2005.
2. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGrawHill, New Delhi, 2007.
3. Benedict. G.F. “Nontraditional Manufacturing Processes” Marcel Dekker Inc., New York, 1987.
4. McGeough, “Advanced Methods of Machining” Chapman and Hall, London (1998).
5. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, “Material and Processes in Manufacturing” 8thEdition, Prentice Hall of India Pvt. Ltd., New Delhi , 2001.

6. Groover, M.P. “Fundamentals of modern manufacturing processes - Materials, Processes and Systems”, 3rd Edition, John Wiley and Sons Inc., 2007.

Course Outcomes:

1. Understand various advanced machining methods commonly used for the effective processing of smart and typical engineering materials.
2. Understand and carry out metal forming, casting and welding process analysis.
3. Understand the working principle of various special processing methods.

MEPE321: ADDITIVE MANUFACTURING

Pre-requisite: Production Technology -II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Additive Manufacturing is one of the pillars in Industry 4.0 technology. AM has changed the way of manufacturing the components for various applications.

UNIT I

Introduction To Additive Manufacturing (AM): Overview – History – Need- of Additive Manufacturing, Classification of AM processes and 7 families of AM, fundamental engineering aspects. Difference between Additive and Subtractive Manufacturing, AM benefits, 3D printing and additive manufacturing, Generic AM Process, Rapid Prototyping Product development, AM applications timeline evolution, Additive Manufacturing applications in Aerospace, Automotive, Electronics, defence and Biomedical. Industrial revolutions, AM in Industry 4.0, current development in the field of AM. **(8 hrs)**

UNIT II

CAD for AM: Basic Concept: Digitization techniques – Model reconstruction – Data processing for AM Technology: CAD model preparation – Part orientation and support generation – Model slicing –Tool path generation (preparatory (G) and miscellaneous (M) code generation) – Softwares for AM Technology- Cura, Mimics, Magics. STL file generation, STL file format- ASCII encoding and Binary encoding, defects in STL file, STL file repair, Design for Additive Manufacturing- Levels of AM deployment, Business impact of industrial AM, Innovative product design, Reverse Engineering, Application Geometric Model Development, Digitization techniques- Contact and Non-Contact Methods**.** **(10 hrs)**

UNIT III

AM Processes: Fused deposition modelling (FDM)- Principle, process parameters of FDM, Cause effect diagram, advantages, applications and defects in FDM printing, Stereolithography (SLA)-Binder Jetting-Material jetting-Powder bed fusion AM processes involving sintering and melting- Principle, process, advantages, effect of process parameters and applications, Directed energy deposition-Sheet lamination: Principle, process, advantages, effect of process parameters and applications. **(14 hrs)**

UNIT IV

Material Science Aspects and Case Study: Different materials used in AM- polymers filaments materials (ABS, PLA, PCs, PEI, Nylon and other), metals (SS316L, Inconel 625 and 718, AlSi10Mg), multifunctional and graded materials. Effect of AM process parameters on built parts, Mechanical properties and Metallurgical characterization of key materials, A case study based on experimental development of 3D components as a mini project**.**

(8 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer, 2010.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific, 2010.
3. John O. Milewski, Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewelry, Springer- 2017
4. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
5. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Course Outcome

CO 1: To comprehend fundamentals of Additive manufacturing (AM) with different types of AM process.

CO 2: To apply various designing and slicing techniques to create tool path for AM.

CO 3: To comprehend fundamentals of different AM processes classified based on ASTM.
CO 4: To acquire knowledge of different materials and create AM components by applying fundamental knowledge of different AM process.

MEPE322: TRIBOLOGY

Pre-requisite: **MD-I**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course will introduce the students to the fundamental concepts related to friction, wear and lubrication. Therefore, the learning objectives of this course are:

- To develop an understanding of tribology, surface topography and the importance of tribology in engineering
- To understand the basic laws and theories of friction and wear along with measurement techniques
- To understand the types and properties of lubricants
- To gain knowledge regarding the mathematical equations governing the performance of various bearings and other transmission components

UNIT – I

Introduction to Tribology: Introduction to tribological systems and their characteristic features, Analysis and assessment of surface topography, deterministic and stochastic tribo-models for asperity contacts, techniques of surface examination, tribological properties of surfaces.
Friction: Quantitative laws of sliding friction, causes of friction, adhesion theory, laws of rolling friction. **(10 hrs)**

UNIT – II

Wear: Introduction, mechanism of wear, types of wear, quantitative laws of wear, wear resistance materials.
Lubrication and Lubricants: Introduction, dry friction, boundary lubrication, hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, functions of lubricants, types and properties of lubricants, lubricant additives, solid lubricants. **(10 hrs)**

UNIT – III

Bearings and Bearing Materials: Geometry and pressure equation of journal bearing, hydrostatic bearings, thrust bearings, porous bearings and hydrodynamic gas bearings. Journal bearings with specialized applications. General requirements and different types of bearing materials**.** Elasto-hydrodynamic lubrication: Principles, application to rolling contact bearings, cams, gears. **(10 hrs)**

UNIT – IV

Tribological Testing Techniques: Inclined plane method for friction measurement, Pin-on-disk method for friction and wear measurement, Dry sand abrasion resistance test, Four ball test for estimation of EP and wear preventive properties, Solid particle erosion test, Cavitation erosion test, Jet type and pot type slurry erosion test, Liquid droplet impingement erosion, Potentiodynamic and Electrochemical corrosion testing (Tafel plot), Case studies on wear assessment of composite materials. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Principles of Tribology by J. Halling, Macmillan
2. Mechanics and Chemistry in lubrication by Dorinson and Ludema, Elsevier
3. Friction and wear of Materials by E. Robinowicz, John Wiley
4. Principles of Lubrication by A. Cameron, Longmans
5. Introduction to Tribology of Bearings by B.C. Majumdar, S Chand
6. Engineering Tribology by Prasanta Sahoo, PHI
7. Friction and Lubrication by E.P.Bowden and Tabor.D, Heinemann Educational Books Ltd.

Course Outcomes

CO 1: The students will be able to analyse the contact between rough surfaces and determine important tribological characteristics.

CO 2: The students will be able to correlate material properties and other parameters with friction and wear behaviour.

CO 3: The students will be able to select lubricant and evaluate load carrying capacity, friction coefficient etc. for various bearings and transmission components.

CO 4: The students will be able to understand various techniques for the measurement of friction and wear

MEPE323: MECHATRONICS

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	00	00	3	40

Brief Description about the course

UNIT-I

Introduction to Mechatronics and its Systems: Evolution, Scope, Measurement Systems, Subsystems and integration of mechanical & electrical systems using computer based control, Control Systems, open and close loop systems, Practical applications of mechatronics, Mechatronics approach.
Basics of Digital Technology: Electronic Components & Devices, Number System, Logic gates, Boolean algebra, Logic Functions, Applications. **(10 hrs)**

UNIT -II

Sensors and transducers: Introduction, performance terminology-Displacement, Position and Proximity, Velocity and motion, force, Fluid Pressure-Temperature Sensors-Light Sensors-Selection of Sensors-Signal Processing.

Pneumatic and Hydraulic actuation systems: Actuation systems, Pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, process control valves, rotary actuators. **(10 hrs)**

UNIT -III

Mechanical actuation systems: Mechanical systems, types of motion, kinematics chains, cams, gear trains, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection.

Microprocessor: Introduction, Architecture, Pin Configuration, Instruction set, Programming of Microprocessors using 8085 instructions-Interfacing input and output devices-Interfacing D/A converters and A/D converters, Applications, Temperature control, Stepper motor control. **(10 hrs)**

UNIT -IV

Programmable Logic Controller: Introduction, Basic structure, Input/output Processing, Programming, Mnemonics, Timers, Internal relays and counters, Data handling, Analog Input/Output, Selection of a PLC.
Robotics: Introduction, types of robots, Robotic control, Robot drive systems Robot end effectors, selection parameters of a robot, applications. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference Books

1. Bolton W., “Mechatronics”, Longman, Second Edition, 2004.
2. Histand Michael B. and Alciatore David G., “Introduction to Mechatronics and Measurement Systems”, McGraw Hill International Editions, 2003.
3. Kamm, M.L.J., Mechatronics, Prentice Hall of India, New Delhi (2007).
4. HMT Ltd., “Mechatronics”, Tata McGraw Hill Publishing Co. Ltd., 1998.
5. A Text Book of Mechatronics, R K Rajput.
6. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, Tata McGraw-Hill publishing company Ltd, 2003.
7. Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing, Prentice Hall, New Jersy (1996).

Course outcomes

At the end of the course student will be able to

CO1 Understand the basic concepts of mechatronics, digital technology and their applications.
CO2 Understand the functioning of various types of sensors, transducers and their applications.
CO3 Understand the concept of pneumatic, hydraulic and mechanical actuation systems.
CO4 Perceive the functioning of microprocessors, Programmable logic controllers, their architecture, structure and applications.
CO5 Understand the basics of robotics**,** robot types, their drive systems and applications.

MEPE324: FINITE ELEMENT METHOD

Pre-requisite: Strength of Materials -II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course is an introduction to solving different types problems existing in the area of fluid, solids, heat which are described with their respective governing differential equations. The course compares the performance of finite element with the previously well established finite difference. The primary focus of the course is to expose the students to solving problems in these seemingly areas from the governing equation. The course provides a well-balanced approach, covering both the physical concepts and mathematical operations, supplemented with practical examples and exercises. By the end of the course, students will possess a strong foundation in finite elements, enabling them to effectively apply essential principles, laws, and relevant equations in the engineering design of machines for specific applications.

UNIT-I

Introduction to Finite Element Method with Integral Formulations And Variational Methods: Basic Concept, Historical background, Engineering applications, general description, Comparison with other methods. Need for weighted-integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach. **(7 hrs)**

UNIT-II

Finite Element Techniques: Model boundary value problem, finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials. **(12 hrs)**

UNIT-III

Applications To Solid, heat and fluid mechanics problems and Structural Mechanics Problems: External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, Analysis of trusses, frames and solids of revolution, computer programs.Variational approach, **(10 hrs)**

UNIT-IV

Applications fluid mechanics problems: Galerkin approach, one-dimensional and two-dimensional steady-state problems for conduction, convection and radiation, transient problems. Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, Solution of incompressible and compressible fluid film lubrication problems.

(11 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. The Finite Element Method byZienkiewicz, Tata McGraw Hill
2. The Finite Element Method for Engineers by Huebner, John Wiley
3. An Introduction to the Finite Element Method by J.N.Reddy, McGraw Hill
4. The Finite Element Method in Engineering by S.S. Rao, Pergamon Press

Course Outcomes

CO1: At the end of the course student will be able to solve the problems existing in various areas of fluid, solids and great from the governing equation point of view.

CO2: They would program the various methods existing in this area and thus will be able to implement design concepts to practical problems.

CO3: Select the suitable type of material considering the type of working conditions they are to withstand.

MEPE325: VEHICLE DYNAMICS

Pre-requisite: DOM, SOM-II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Vehicle Dynamics is the study of vehicle motion, tasked with exploring the behaviour of a vehicle in response to driver inputs and those of the environment. The theory of vehicle dynamics and its application underpins the development of automobiles and race cars, contributing extensively to their design and subsequent operation.

The objectives of the course are:

1. To provide information about various aspects of kinematics and dynamics of an automobile.
2. To understand the dynamic behavior of various components of the vehicles e.g. suspension system, tires etc.
3. To understand the vehicle stability and performance under the different external conditions.
4. To understand the safety and control features of longitudinal, lateral and vertical dynamics.

UNIT-I

Basics of Vibrations: Classification of vibration, mechanical vibrating systems, human comfort, modeling and simulation studies, Model of an automobile, one degree of freedom, two degrees of freedom systems, free forced and damped systems, vibrations magnification and transmissibility. Vibration absorber. Modal analysis. (**10 hrs)**

UNIT-II

Suspension: Functioning of suspension system, Vehicle dynamics affected due to suspension, Chassis spring, Effective spring rate, Different types of suspension systems- Leaf, Helical, Torsion, Fluid and Air suspension, Design of suspension system, Mechanics of suspension system. (**08 hrs**)

UNIT-III

Stability of vehicle**:** Load distribution, stability of vehicles (on road and of road) on a curved track and on a slope. Gyroscopic effects, weight transfer during acceleration and braking over turning and sliding. Rigid vehicle stability and equations of motion cross wind handling. **(06 hrs)**

Vehicle Handling: Over steer, under steer, steady state cornering. Effect of braking driving torques on steering. Effect of camber transient effects in cornering. Directional stability of vehicles. **(06 hrs)**

UNIT-IV

Tires: Types of Tires, Relative merits and demerits Ride characteristics, Behavior while cornering, slip angle cornering force, power consumed by a tire, Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tires, cornering properties of tires, ride properties of tire, Effect of driving consumed by a tire, Effect of driving braking torque, Gough's tire characteristics, Effect of camber thrust. **(08 hrs)**

Performance Characteristics of Vehicles: Equation of motion and maximum tractive effort. Aerodynamics forces and moments. Power and transmission characteristics. Prediction of vehicle performance. Braking performance. **(02 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Rao J.S and Gupta. K "Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., 2002.
2. Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 2005
3. Groover, "Mechanical Vibration", 7th Edition, Nem Chand &Bros, Roorkee, India, 2003.
4. JG.Giles, 'Steering, Suspension tyres', Illife Books Lid London 1975
5. W.Steeds, 'Mechanics of road vehicle' Illiffe Books Ltd, London 1992
6. J.Y. Wong, Theory of Ground Vehicles, John Wiely& Sons Inc., New York. 1978
7. P.M.Heldt, 'Automotive chassis', Chilton Co ., Newyork, 1982
8. J. R. Ellis, 'Vehicle Dynamics', Business Books, London, 1969.

Course outcomes

On completion of the course the student will be able to:

CO1: Get in-depth exposure and analyze the dynamic behavior of vehicle.

CO2: Apply scientific and technical knowledge to the field of automobiles.

CO3: Understand the concept of performance, handling and ride characteristics of a vehicle dynamics

CO4: To develop extended experience in solving problems related to a broad range of vehicle systems and components. and Evaluate the vehicle dynamic behaviors.

MEPE-326: MECHANICS OF COMPOSITE MATERIALS

Pre-requisite: Material Science

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course is designed for B.Tech students as an introductory course in building foundational knowledge in 'composite materials'. It introduces the concepts of: (i) definition, characterization and classification of composites, (ii) Micro-mechanical and Macro-mechanical analysis of composite laminates and (iii) Metal matrix composites, their fabrication techniques and the properties of MMC's. Following will be course learning objectives.

1. To understand the concept of composite materials, its uses, applications and processing of fibre reinforced composites.
2. To understand micro mechanical analysis and macro mechanics of composite materials.
3. To understand the biaxial strength theories and the macro mechanical analysis of laminates.
4. To understand the concept of MMC's, their uses, applications and their mechanical properties.

UNIT- I

Introduction To Composite Materials Applications: Introduction To Composite Materials: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Applications: Automobile, Aircrafts. missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

Fiber Reinforced Plastic Processing: Lay up and curing, fabricating process, open and closed mould process, hand lay up techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding. **(10 hrs)**

UNIT- II

Micro Mechanical Analysis of a Lamina: Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Numerical problems.

Macro Mechanics of a Lamina: Macro Mechanics of a Lamina Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. **(10 hrs)**

UNIT - III

Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problems.

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) , Special cases of laminates, Numerical problems.**(10 hrs)**

UNIT - IV

Metal Matrix Composites Fabrication Process For MMC's : Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application. Fabrication Process For MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

Properties of MMC'S: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.

Case study 1: Fabrication and investigation of different properties of an MMC used for Automotive part like car chasis, drive shaft, piston, cylinder and its liner, connecting rod etc

Case study 2: To develop and investigate the fibre reinforced composites for industrial applications like boat hulls, swimming pool panels, racing car bodies, shower stalls, bathtubs, storage tanks etc **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books

1. Mechanics of Composite Materials - Autar K. Kaw, CRC, Taylor and Francis.
2. Mechanics of Composite Materials- Robert M Jones, CRC Press.
3. Principles of composite material mechanics - Ronald F Gibson, CRC Press

Course Outcomes

At the end of the course student will be able to

CO1: Understand the concept of composite materials, its uses, applications and processing of fibre reinforced composites.

CO2: Understand micro mechanical analysis and macro mechanics of composite materials.

CO3: Understand the biaxial strength theories and the macro mechanical analysis of laminates.

CO4: Understand the concept of MMC's, their uses, applications and their mechanical properties.

MEPC401: I.C. ENGINES AND GAS TURBINE

Pre-requisite: TD, Fluid Machines

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

This course provides an introduction to internal combustion (IC) engine, its working principles, Combustion in I.C. Engines, Elements of Fuel System in S.I. and C.I. Engine, Lubrication and Cooling systems, Testing and Performance of I.C. Engine, Air Pollution and Modern Developments in I.C. Engines. It also provides an introduction to air compressors and gas turbines, their types and applications.

UNIT-I

Introduction: Introduction to internal & external combustion engines; classification, cycle of operation in four stroke and two stroke I.C. Engines, Valve timings, Wankel engine.
Analysis of Air Standard Cycles and Fuel Air Cycles: Air standard cycles, Ideal air standard cycles, Otto cycle, Diesel cycle, Dual cycle; comparison of these cycles; Sterling and Ericsson cycles; Air standard efficiency; mean effective pressure, Actual cycles and actual processes taking place in engines. **(6 hrs)**

UNIT-II

Combustion in I.C. Engines**:** SI engines: Ignition Limits, stages of combustion, Effect of engine variables on Ignition Lag and flame-propagation, Abnormal combustion, Detonation and control of detonation, Pre-ignition, Octane rating of fuels, SI engine combustion chambers. CI engine: stages of combustion, Delay period, variables affecting delay period, Diesel knock, Cetane rating, CI engine combustion chambers**.**

Elements of Fuel System in S.I. and C.I. Engine: SI engines: Requirements of a good carburetor, Simple carburetor, Complex carburetor, Calculation of air-fuel ratio for a simple carburetor. Electronic fuel injection in S.I. Engine. CI engine: Requirements of Diesel Injection System, Types of injection systems, Fuel pumps. **(10 hrs)**

UNIT-III

Lubrication and Cooling: Total engine friction, Function of the lubrication systems, properties of lubricating oil, rating of oils, Lubrication systems, engine performance & lubrication. Necessity of engine cooling, Cooling systems, Water cooling, air cooling, Radiators**.**

Testing and Performance of I. C. Engine: Engine Performance Parameters: Indicated power, brake power, friction power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, volumetric efficiency, relative efficiency or efficiency ratio, specific output, specific fuel consumption, brake specific fuel consumption, indicated specific fuel consumption, Air fuel ratio, Stoichiometric air fuel ratio.
Air Pollution and Modern Developments in I C Engines**:** Pollutants and their ill effects, Pollutants from Gasoline and Diesel Engines and their control. Alternate fueled engines: Alcohol, hydrogen etc., current scenario on the pollution front. **(15 hrs)**

UNIT-IV

Air compressors: Single stage reciprocating air compressors, work input, volumetric efficiency, isothermal efficiency, Advantages of multi stage compression, two stage compressor with inter cooling, optimum pressure ratio. Rotary air compressors and their applications.
Gas Turbines: Brayton cycle, components of a gas turbine plant, open and closed type, optimum pressure ratio, Improvements upon the basic cycle, multi stage compression with inter cooling, multi stage expansion with reheating, Regeneration, Applications and case study of gas turbine. **(9 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text books/References:

1. Ganeshan V., “Internal Combustion Engines”, McGraw Hill, New Delhi, 2007.
2. Heywood J.B., “Internal Combustion Engine Fundamentals” McGraw Hill, Singapore, 2002.
3. H.N. Gupta, “Fundamentals of Internal Combustion Engines”, Prentice Hall India, 2006.
4. Shyam K. Agrawal, “Internal Combustion Engines” New Age International Ltd., New Delhi, 2006.
5. M.L. Mathur and R.P. Sharma, “Internal Combustion Engine Fundamentals” Dhanpat Rai, New Delhi, 2010.
6. Ganeshan V., “Gas Turbine”, McGraw Hill, New Delhi, 2010.

Course Outcomes:

At the end of course, the students will be able to:
CO1: Understand the air standard cycles, fuel air cycles and actual cycles. Also explain the combustion phenomenon in SI and CI engine.
CO2: Illustrate the various engine systems like cooling, fuel injection, and lubrication system.
CO3: Evaluate the performance of SI and CI engine.
CO4: Summarize the performance of Air compressors and Gas Turbines.

MEPC402: MECHANICAL VIBRATIONS

Pre-requisite: DoM

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description of the course

Vibration is a common phenomenon occurring in a mechanical system. The study of a dedicated course is required to understand the fundamental and advance concepts of mechanical vibrations for engineers and designers. Following are the course learning objectives:

1. To understand the periodic disturbances caused by external excitation, rotational and reciprocating imbalance, and support excitation affect a machine's performance.
2. To acquire the knowledge for vibration analysis of physical bodies.
3. To learn Mathematical Modelling of Mechanical Systems for vibration analysis.
4. To learn methods of Vibration isolation of Mechanical systems under periodic inputs.

UNIT- I

Fundamental of Vibrations: Introduction, Importance of study Vibration, Definitions, Classifications of Vibration, Kinematics of simple vibrating motions, Simple harmonic motions, Vector Method and Complex Method representation of a harmonic motion, Fourier series representation of periodic Inputs, Vibration Analysis Procedure, Mathematical Model for Vibration Analysis. **(06 hrs)**

Free Vibrations of a Single Degree of Freedom Systems: Degrees of freedom, equations of motions, general solution of equation of motions, Rayleigh s Energy Method, Undamped and Damped free vibrations of Mechanical Systems. Logarithmic Decrement, Stability of Systems **(04hrs)**

UNIT- II

Forced Vibrations of a Single Degree of Freedom Systems: Forced vibrations of the damped and undamped systems, Transient and Steady state response, Various type of damping, Forced vibration – due to external excitation; due to rotating and reciprocating unbalance; due to excitation of the support, Transmissibility and isolation, Self-Excitation and Stability Analysis, Vibration measuring Instruments. (**10 hrs**)

UNIT - III

Two Degrees of Freedom Systems: Equations of Motion for Forced Vibration, Free Vibration Analysis of an Undamped System, principal modes, Damped Free Vibrations, Forced Vibration with Harmonic excitation and Vibration Absorber.

Multi-Degrees of Freedom Systems: Modeling of Continuous Systems as Multi-degree of-Freedom Systems, Using Newton s Second Law to Derive Equations of Motion, Influence Coefficients, Undamped Forced Vibration, Generalized Coordinates, Coordinate Coupling, Principal Coordinate, Eigenvalue Problem, Modal Analysis. (**10hrs**)

UNIT - IV

Determination of Natural Frequencies of Multi-Degrees of Freedom Systems:

Numerical Methods: Dunkerley’s Method, Rayleigh’s method, Method of Matrix iteration, Holzer’s method, Rayleigh–Ritz method.

Continuous Systems: Transverse vibration of strings or cable, longitudinal vibration of bars, lateral vibration of beams, torsional vibration of circular shafts, Vibration of Membranes. Critical speeds of shafts: Critical speed of Undamped and Damped light shaft having Single Disk.

Case studies: Case studies on Mechanical Vibration of the rotating components and other mechanisms. (**10 hrs**)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Mechanical vibration by S. S. Rao, Pearson Education
2. Mechanical Vibration by Thomson, Prentice Hall
3. Mechanical Vibration by Den Hartog, McGraw-Hill
4. Introductory course on Mechanical Vibrations by Rao and Gupta, Wiley Eastern
5. Mechanical vibration by G.K. Grover, Nem chand & Brothers

Course Outcomes

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

CO1: Perform vibration analysis of the Mechanical systems using mathematical modelling

CO2: Form the differential equations of motion of the Mathematical model for a Mechanical system for vibration analysis.

CO3: Solve governing equation of motions of the Mechanical systems using Numerical Methods as well as exact analysis.

CO4: Predict response of the Mechanical Systems under periodic inputs.

MEPC 403: COMPUTER AIDED DESIGN

Pre-requisite: **MD-II**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course will introduce the stuents to the geometric modelling and engineering analysis techniques required to model and analyze objects for application in CAD, CAM, Computer Graphics and many other engineering applications. To this end, the learning objectives of this course are:

- To understand 2D & 3D geometric transformation techniques and apply the same to obtain orthographic, perspective, axonometric and oblique projections
- To develop mathematical models to represent curves and surfaces
- To understand and generate solid geometries
- To understand the fundamentals of Finite Element Method and apply the same for engineering analysis

UNIT – I

Introduction: **I**ntroduction to design process and role of computer in design, Historical developments, Industrial look at CAD/CAM, Basics of geometric and solid modeling, explicit, implicit, intrinsic, extrinsic and parametric equations coordinate systems

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, 3D rotation about an arbitrary axis, 3D reflection through an arbitrary plane, orthographic, Axonometric, Oblique and perspective projections. **(10 Hrs)**

UNIT – II

Curves: Algebraic and geometric forms, Analytical & Synthetic Curves, tangents and normal, blending functions, re-parametrization, straight lines, conics, cubic splines, bezier curves and B-spline curves; Rational curves, Non-uniform Rational curves, NURBS; Curve manipulation.

Surfaces: Algebraic and geometric forms, Analytical and Synthetic Surfaces, tangents and twist vectors, normal, blending functions, sixteen-point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surfaces, Coons surface, Triangular patches. **(10 Hrs)**

UNIT – III

Solids:Solid models and representation scheme, Fundamentals of Solid Modeling, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, Half spaces, Octree Encoding, Pure Primitive Instancing**. (10 Hrs)**

UNIT – IV

Introduction to finite element analysis: Introduction to CAE and Finite Element Method, Finite element formulation for one dimensional bar and beam elements, Plane stress and plane strain problems, Axisymmetric formulation, Two dimensional problems using constant strain triangles and higher order elements,

Case Studies: Develop computer codes for Wireframe modelling and 3D transformations of simple solids such as cuboid, pyramid, wedge etc; Geometric modelling and mesh generation for an involute profile spur gear; Stress analysis of a simply suppoeted beam subjected to uniformly distributed load. **(10 Hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. CAD/CAM by Groover and Zimmer, Prentice Hall
2. CAD/CAM: Theory and Practice by I. Zeid, Tata McGraw Hill
3. Mathematical Elements for Computer Graphics by Rogers & Adams, McGraw Hill.
4. Computer Aided Engineering Design by Anupam Saxena and Birendra Sahay, Springer
5. An Introduction to the Finite Element Method by J.N.Reddy, McGraw Hill
6. The Finite Element Method in Engineering by S.S. Rao, Pergamon Press
7. Textbook of Finite Element Analysis by P. Seshu, PHI Learning

Course Outcomes

CO 1: Geometrically transform 2D & 3D entities (such as, lines, surfaces and solids)
CO 2: Generate curves and surfaces by developing mathematical models
CO 3: Model components using solid modeling techniques
CO 4: Perform engineering analysis using Finite Element Method

MEPC414: I.C. ENGINES AND GAS TURBINE (P)

Pre-requisite: **NIL**

L	T	P	Credits	Total contact hours
0	0	2	1	24

Brief Description about the course:

This course provides an experimental knowledge of computerized controlled single cylinder 4 –stroke Diesel Engine, computerized controlled 4- stroke high – speed Diesel Engine, multi cylinder petrol engine, effects of emission formation of IC engines. It also provides an introduction to air compressors and gas turbines, their types and applications.

Course Content:

1. To make a trial on computerized controlled single cylinder 4 –stroke Diesel Engine to calculate B.H.P., S.F.C. and to draw its characteristics curves.
2. To make a trial on computerized controlled 4- stroke high – speed diesel engine and to draw its Heat Balance Sheet.
3. To make Morse Test to calculate IHP of the multi cylinder petrol engine and to determine its mechanical efficiency.
4. Study of different types of lubrication systems.
5. Study of fuel injection systems of a C.I. Engine.
6. To study battery ignition system for four cylinders S.I. engines and requirements of ignition system.
7. To study magneto ignition system for SI engine having four cylinders and differences between magneto and battery Ignition system.
8. Dissembling & assembling of the simple Carburetor.
9. To study Boiler and its components.
10. To study open cycle constant pressure combustion gas turbine with inter cooler, regenerator and reheater.
11. General study of Wankel engine.
12. To study variable compression ignition engine.
13. To study of braking system of automobile in the lab.
14. Measurement of exhaust emission by using Exhaust gas analyzers.

Text Books/Reference:

1. *Thermal Engineering* by *R.K.Rajput* 7th edition book
2. An Introduction to Thermodynamics, Y.V.C. Rao, University Press (India) Private Limited, Revised Edition, 2004).
3. Thermodynamics: an Engineering Approach, Y.A.Cengal and M.A.Boles, McGraw Hill (Fifth edition).
4. Fundamentals of Classical Thermodynamics, G.VanWylen, R.Sonntag and C.Borgnakke, John Willey & Sons (Fourth edition).
5. NPTEL Videos courses of Basic and Applied Thermodynamics (https://nptel.ac.in/course.php)
6. Edx Videos courses of Thermodynamics (https://courses.edx.org/courses/ coursev1:IITBombayX+ME209.1x+1T2017 /course/)
7. Ganeshan V., “Internal Combustion Engines”, McGraw Hill, New Delhi, 2007.
8. Ganeshan V., “Gas Turbine”, McGraw Hill, New Delhi, 2010.
9. M.L. Mathur and R.P. Sharma, “Internal Combustion Engine Fundamentals” Dhanpat Rai, New Delhi, 2010.

Course Outcomes:

At the end of course, the students will be able to
CO1: Identify the various types of I.C. Engines and Cycles of operation. Also express the effect of various operating variables on engine performance.
CO2: Illustrate the various engine systems like cooling, fuel injection, and lubrication system.
CO3: Understand the effects of emission formation of IC engines, its effects and the legislation standards.
CO4: Understand the performance of Gas Turbines.

MEPC415: MECHANICAL VIBRATION (P)

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
0	0	2	1	24

Brief description of the course

Mechanical Vibration is a common phenomenon occurring in a mechanical system. The experimental studies are required to understand the fundamental and advance concepts of mechanical vibrations. Following are the course learning objectives:

1. To develop the understanding of basic concepts of Mechanical Vibrations with the help of experiments.
2. To find natural frequency of free and forced vibrations of undamped and damped mechanical systems for understanding the theoretical concepts of Mechanical Vibrations.
3. To find viscous damping from the response curve of damped free vibrations of a Mechanical System.
4. To develop the understanding of Torsional Vibrations.
5. To verify some of the methods of finding natural frequency of Mechanical Systems.

COURSE CONTENTS:

1. To study undamped free vibrations of equivalent spring mass system & determine the natural frequency of vibrations.
2. To study the free vibrations of the system for different damper setting. Draw the decay curve and determine the log decrement and damping factor. Determine the natural frequency.
3. To study the torsional vibrations of a single rotor shaft system and to determine the natural frequency.
4. To perform the experimental modal analysis using the Modal analysis apparatus.
5. To determine the two frequencies of the torsional spring type double pendulum and compare them with theoretical values.
6. To determine the radius of gyration of given bar by using Bifilar suspension.
7. To verify the Dunkerley's rule.
8. To study the forced vibrations of the system with damping. Plot magnification factor vs. frequency and phase angle vs. frequency curves. Also, determine the damping factor.
9. To practice the measurement of the vibrations of any mechanical component using the vibration analysis equipment i.e accelerometers, Data acquisition system.

Course Outcomes:

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

CO1: Perform Vibrations analysis of a Mechanical System or component.

CO2: Determine the system properties of a component of machine or Machine itself by performing free vibrations tests.

CO3: Determine the viscous damping present in a Mechanical system.

CO4: Understand theoretical concepts of Mechanical Vibrations. Analyse the response of the Vibrations Test to understand the theoretical results obtained from Mathematical Modelling of the Mechanical System under periodic input.

MEPC416: COMPUTER AIDED DESIGN (P)

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
00	00	2	1	24

Brief Description about the course

Learning objectives of this course are:

- To get the knowledge of modelling software
- To understand the 2D, 3D and assembly drawing features of different CAD software.
- To understand and generate 2D entities using programming techniques

Course Contents:

1. Draw 3D parts, assembly and drafting
2. To perform 2D scaling, reflection, rotation and translation transformations of a geometric entity.
3. To perform 3D scaling, reflection, rotation and translation transformations of a geometric entity and show its application for a unit cube.
4. To generate the top, front and side views of a truncated cube.
5. To generate isometric projection and apply it to view a given object.
6. To generate dimetric projection and apply it to view a given object in different orientations.
7. To perform single point perspective projection and use it to view a truncated cube.
8. To perform joining a set of points in space by Hermite curve segments and demonstrate the manipulation of curve shape by varying the geometric conditions.
9. To generate a Bezier curve for a given set of control points and demonstrate the manipulation of curve shape by varying the geometric conditions.
10. To generate a B-Spline curve for a given set of control points and demonstrate the manipulation of curve shape.
11. To generate and view a ruled surface between two given rails.
12. To generate and view a Bezier surface for a given mesh of control points.

List of Software Required

1) SOLIDWORKS/CATIA/Auto Desk INVENTOR/PTC Creo
2) MATLAB

Course Outcomes

At the end of the course student will be able to

CO1: Draw the 2D, 3D drawing of complex machine components
CO2: Design contours and surfaces using modelling software.
CO3: Generate 2D entities using MATLAB

MEPE 404: COMPUTER INTEGRATED MANUFACTURING

Pre-requisite: MD-II, Industrial Engg.

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course:

To introduce the importance, concepts and components of computer integrated manufacturing.

UNIT-I

Introduction: Introduction to manufacturing enterprise, External and internal changes, World-class winning criteria, Introduction to CIM concepts, Three step process for CIM implementation.

Manufacturing Systems: Manufacturing classifications, Product development cycle, Enterprise organization. **(10 hours)**

UNIT-II

Design Automation: Computer-Aided Design and Engineering: Introduction, General system operation, CAD classification: Hardware and software platforms, Application of CAD to manufacturing systems, Design for manufacturing and assembly, Computer-aided engineering analysis and evaluation.

Manufacturing Planning and Control: Introduction, planning the manufacturing planning and control system, master production schedule, inventory management, product data management.

(10 hours)

UNIT-III

Material Planning, Production Scheduling and Operating Systems: Material requirement planning, Capacity requirement planning, MRP II, Just-in-time manufacturing.

Enterprise Resource Planning: MRP II – a driver of effective ERP systems, information technology, the decision to implement ERP system, Features of modern manufacturing planning and control systems. **(10 hours)**

UNIT-IV

Production Support Machines and Systems: Industrial robots, automated material handling systems, automated guided vehicles, automated storage and retrieval systems.

Machine and System Control: System overview, Cell control, Proprietary versus Open system interconnect software, Device control, programmable logic controllers, Computer numerical control, Automatic tracking, Network communications. **(10 hours)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Reference Books:

1. Computer-integrated manufacturing, James A. Rehg and Henry W. Kraebber, Pearson Education.
2. Computer Integrated Manufacturing Technology and Systems, U. Rembolt, C. Blume, R. Dillmann, Dekker,
3. Computer Integrated Design and Manufacturing, D.D. Bedworth, M.R. Henderson, P.M. Wolfe, McGraw Hill.
4. Systems Approach to Computer Integrated Design and Manufacturing, N. Singh, John Wiley & Sons.
5. Automation Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson

Course outcomes:

CO 1 : To understand CIM and its scope
CO 2 : To understand product design and manufacturing in CIM environment
CO 3 : To understand manufacturing planning and control in CIM environment
CO 4 : To understand hardware and software requirements for CIM as well as implementation of CIM

MEPE405: PRODUCT DESIGN AND DEVELOPMENT

Prerequisite:MD-II

L	T	P	Credits	Total Contact Hours
3	-	-	3	40

Brief Description about the course

This course blends the perspectives of marketing, design, and manufacturing into a single approach to product development. As a result, students are provided with an appreciation for the realities of industrial practice and for the complex and essential roles played by the various members of product development teams. The course is intended to provide the following benefits:

- Competence with a set of tools and methods for product design and development.
- Develop abilities amongst learners to create a new product.
- Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective.
- Reinforcement of specific knowledge from other courses through practice and reflection in an action-oriented setting.
- Enhanced team working skills.

UNIT-I

Introduction: Characteristics of Successful Product Development , Who Designs and Develops Products? ,Duration and Cost of Product Development , The Challenges of Product Development , The Product Development Process ,Concept Development: The Front-End Process , Generic Product Development Process.

Opportunity Identification: What Is an Opportunity, Structure of Opportunity Identification and its process , Process to Generate , Sense , Screen and develop Opportunities. Product Planning: Product Planning Process, Product Development Projects , Evaluation of Projects , Pre-Project Planning

Customer Needs Identification: Importance of t Needs identification, Process of Identifying Customer Needs , Art of Eliciting Customer Needs ,Needs Interpretation, Needs Hierarchy and relative Importance. **(10 Hrs)**

UNIT-II

Product Specifications: Concept of Product specifications, steps to establish the Target specifications, Setting of Final Specifications, Technical and Cost Models

Concept Generation: Activity of Concept Generation , Methods of Concept Generation, Problem Decomposition, Concept Classification Tree, Concept Combination Table, Managing the Exploration Process,

Concept Selection: Importance of Concept Selection , Methods of Concept Selection, Concept Screening and Scoring, Combining and Improving Concepts.

Concept Testing: Purpose of the Concept Testing, Methods, formats and Analysis for Testing, Selection methods for Concepts. **(10 Hrs)**

UNIT-III

Industrial Design: What Is Industrial Design? Assessing the Need for Industrial Design , Importance of Industrial Design to a Product, Parameters for Industrial Design, Impact of Industrial Design, Industrial Design Process and its Management ,Assessing the Quality of Industrial Design, Ergonomic / Aesthetic Needs.

Design for Manufacturing & Assembly: Definition of DFM, estimating manufacturing cost, reducing component, assembly and support costs, design for assembly, design for disassembly, design for environment.

Design for Environment: What Is Design for Environment? , Design for Environment Process - Drivers, Goals, and Team, Application of DFE Guidelines to the Initial Product Design.

Design for Robustness: Concept of Robust Design, Design of Experiments , Robust Design Process, Identification of Control Factors, Noise Factors. **(10 Hrs)**

UNIT IV

Product Management: Concept of Product Management, Functions of a Product Manager, Building a Product and Problem Discovery, Launch of a product**.** **(10 Hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. K.T. Ulrich and S.D. Eppinger, “Product design and development”, Tata McGraw Hill
2. Chitale & Gupta, “Product Development”, Tata McGraw Hill
3. Monks, J. G., “Operations Management”, McGraw Hill, 1997.
4. George Dietor, A material and Processing approach, McGraw Hill

Course outcomes

CO 1- Describe an engineering design and development process
CO 2- Demonstrate individual skill using selected manufacturing techniques
CO 3- Employ engineering, scientific, and mathematical principles to execute a design from concept to finished product
CO 4- Work collaboratively on a team to successfully complete a design project and effectively communicate the results of projects and other assignments in a written and oral format

MEPE406: ENGINEERING ECONOMY

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	42

Brief description about the course

Engineering Economy covers to an extensive view of engineering design and manufacturing products of cost analysis and also economic issues overcomes by understanding of linear & balance depreciation feasibility decisions. The proposed course to target the basics of engineering economy domains and scopes. The following learning objectives are subjected such as the basic concepts of the time value of money and economic equivalence, different cash flows and operational and maintenance costs, and different economic analysis methods. The study will also help to learn the break-even cost analysis, replacement decisions of products (life cycle) and specific system, adoption of new sustainable economy practices such circular economy, green economy in manufacturing environments.

UNIT-I

Introduction: The fundamental concepts and objectives of engineering economy, function and uses of engineering economy, Types of engineering economic decision & roles, physical and economic laws, and flow of economy, consumer and producer goods.

Interest and Annuity Relationships: Productivity of capital, nominal and effective interest, interest factors, CAF, PWF, SPWF, SCAF, SFF, and CRF, deferred annuities, perpetuities and capitalized cost, equivalence, gradient factors, GPWF and GUSF. **(10hrs)**

UNIT-II

Depreciation Methods: Define the term of depreciation, types of depreciation & methods of computing depreciation, economic life and mortality data, capital recovery and return. Element of costing: Types of cost , Classification of costs: Direct material, direct labour and overheads, fixed and variable cost, semi-fixed cost, increment, differential and marginal cost, sunk cost and its reasons, direct and indirect cost, prime cost, factory cost, production cost and total cost. **(12hrs)**

UNIT-III

Cost Analysis: Types of cost analysis, Break-even analysis, two and three alternatives, graphical solution, break-even charts, effects of changes in fixed and variable cost, minimum cost analysis, economic order quantity, effect of risk and uncertainty on lot size. Replacement Analysis: Reason of replacement, evaluation of proposals, replacement because of inadequacy, excessive maintenance, declining efficiency, obsolescence, MAPI formula.

(10hrs)

UNIT-IV

Cost Estimation: Difference between cost estimation and cost accounting, qualifications of an estimator, estimating procedure, estimate of material cost and labour cost, estimate of cost in machining, forging, welding and foundry operations.

Sustainable Economy: Basic economy study patterns and their comparison, effect of taxation on economic studies. Sustainable economies: Types of sustainable economies, sustainable economy, circular economy. **(10hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference:

1. Leland Blank, Anthony Tarquin; Engineering Economy, McGrawhill Education (India), New Delhi, 2017.ISBN13: 978-1-25-902740-6
2. William G. Sullivan, C. Patrick Koelling; Engineering Economy, Pearson Education (Asia), 2017.
3. Grant, E.L., Grant, W., and Leavenworth, R.S., Principles of Engineering Economy, John Wiley & Sons, 2015.
4. Eschenbach , T.G., Engineering Economy by Applying Theory to Practice, Oxford University Press, 3rd edition, ISBN-13: 978-0199772766.
5. Robert S. Devine & Robert Devine, “The Sustainable Economy” , An anchor book origin Oct 2020.

Course Outcomes

CO1: Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.

CO2: Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.

CO3: Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.

CO 4: Compute the depreciation of an asset using standard depreciation techniques to assess its impact on present worth.

MEPE407: PRODUCTION PLANNING AND COTROL

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	-	0	3	42

Brief Description about the course

This course imparts knowledge about the various planning and control techniques in a manufacturing or production plant.

UNIT - I

Introduction to PPC and Manufacturing systems: Introduction: Manufacturing function; Elements of production systems; objectives and the ten functions of production planning and control, concept of production and productivity. Types of production systems, Job, Batch and Mass production system, Product, Process and Cellular layouts, Line Balancing using LOT rule.

Product Development & Design: Effect of competition on design, Long-range Planning, Company policy, product analysis, marketing aspects, the product characteristics, functional aspect, operational aspect, durability and dependability, Aesthetic aspect; Economic analysis, Profit and competitiveness, The Three S Concept- Standardization, Simplification and Specialization, Break Even Analysis.

(16 hrs)

UNIT – II

Forecasting: Concepts and applications, demand forecasting, principle of forecasting, forecasting techniques, quantitative and qualitative methods of forecasting, Trend adjusted exponential smoothening, assessment of forecasting error, signals. Aggregate Production Planning and Scheduling: Concept, strategies for aggregate planning: three pure planning strategies, master production scheduling (MPS), and procedure for developing MPS. Scheduling of jobs, Gantt Chart, FCFS rule, Johnson's rule, Problems on sequencing.

(10 hrs)

UNIT – III

Inventory Control: Definition, classification, objectives of inventory control, functions, costs of inventory, economic order quantity, Economic Batch size, Deterministic demand models, POQ model, Safety stock and probabilistic demand models, V.E.D. analysis, S-D-E analysis, F-S-N analysis, H-M-L analysis and ABC analysis.

Process Capability and Control Charts: Introduction to process capability, Indexes Cp and CpK, Computation of sigma level, Number of defects vs. Sigma Level, Introduction to control charts, Causes of variation, Control charts for variables and attributes, X Chart, P Chart, R Chart, C Chart. **(10 hrs)**

UNIT – IV

Case studies with application: Case studies based on application of various tools and techniques. **(6 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Buffa, E.S., and Sarin, R.K., “Modern Production / Operations Management”, John Wiley & Sons,1994
2. Mukhopadhyaya, S.K., “Production Planning and Control – Text and Cases”, PrenticeHall of India,2004
3. Adam, Jr., E.E., and Ebert, R.J., “Production and Operations Management: Concept, Models and Behavior”, 5th Ed., Prentice-Hall of India, 2001
4. Vollman, T.E., Berry, W.L., and Why bark, D.C., “Manufacturing Planning and Control Systems” 4th Ed., McGraw-Hill, 1997
5. Sipper, D., and Buffin, R.L., “Production: Planning, Control and Integration”, McGrawHill, 1997.

Course Outcomes

CO 1: Students will be able to understand the fundamentals of Production Planning and Control.
CO 2: Students will understand major concept of product development and design.
CO 3: Students will become capable to solve real forecasting and aggregate planning problems.
CO4: Students will learn about inventory control concepts, inventory models, inventory costs and ABC Analysis.
CO5: Student will learn to apply the PPC tool and techniques within different manufacturing/production units.

MEPE409: ARTFICIAL NEURAL NETWORK

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course introduces the Neural Networks and Fuzzy logic. In today's highly integrated world, these techniques are powerful means for obtaining solutions to problems quickly and accurately. These techniques build computationally intelligent systems that possess human like abilities to reason, learn and handle the uncertainty and vagueness often inherent in real world problems. These can be used to solve complex practical problems for which conventional mathematical and analytical methods are inefficient.

UNIT - I

Introduction of Artificial Neural Network, Advantages, Biologic neural network, Comparison between Artificial and Biological Network, Basic building blocks of Artificial Neural Network, Artificial Neural Network Terminologies, Fundamental models of Neural Network (McCulloch-Pitts Neuron Model for AND, OR, XOR, ANDNOT function, Learning Rules (Hebbian, perceptron, delta), Hebb Net, Perceptron networks, Adaline , Madaline **(12 hrs)**

UNIT – II

Associative memory models(Auto associative network, Hetero associative Memory Network) Training by (1) Hebb Rule (2) Outer Product Rule. Competitive networks(Hamming Network, Maxnet, Mexican Hat Network) Multi-layer Feed –forward Neural Network(Architecture, Learning Method, Back propagation Method, Design issues of Artificial Neural Network , Applications of Feed-forward Networks **(10 hrs)**

Unit - III

Introduction to Fuzzy logic, Fuzzy versus crisp, Crisp set Theory , operation on crisp sets, properties of crisp sets ,crisp relation (Cardinality, Operations and properties of crisp Relations), Fuzzy sets: Membership function, basic fuzzy set operations, properties of fuzzy sets ,fuzzy relations(Cardinality ,Operations, Properties of fuzzy relations **(8 hrs)**

Unit – IV

Crisp logic, Predicate Logic, Fuzzy logic (Fuzzy quantifiers, Fuzzy inference), Fuzzy rule based system-Formation of Rules, Decomposition of rules, Aggregation of Fuzzy rules) De-fuzzification methods, Air conditioner Controller, Washing Machine controller **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text and Reference Books:

1. Saroj Kauhik and Sunita Tiwari, Soft computing fundamentals, Techniques and Applications , McGraw Hill Education Private Limited
2. S. Rajasekaran & G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI, 2003.
3. S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley - India, 2007.
4. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2007.
5. S. N. Sivanandam , Sumuthi & S. N. Deepa, Introduction to Neural Networks using MATLAB
6. S. N. Sivanandam , Sumuthi & S. N. Deepa, Introduction to fuzzy logic using MATLAB
7. Timothy , J.Ross Fuzzy Logic with Engineering Applications,Wiley,2016

Course Outcomes

CO 1 : Student will be familiar with fundamental theory , concepts and models of neural network

CO 2 : Student will be able to apply neural networks to prediction and pattern classification problems

CO 3 : Student will be familiar with fundamental theory , concepts of fuzzy logic

CO 4 : Students will be able to apply fuzzy logic to solve engineering problems having uncertainty

MEPE410: FATIGUE, FRACTURE & FAILURE ANALYSIS

Pre-requisite: Material Science , Strength of Materials-II

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course is an introduction to the various modes in which a material can fail. The course deals with the various theories suggested which finds application to describe the mathematical background behind the various failure types and the cause for them. The course deals with both the elastic and plastic materials subjected to various loadings and cracks of various orientations and sizes. By the end of the course, students will possess a strong foundation in failure, enabling them to effectively apply essential principles, laws, and relevant equations in the engineering design of machines for specific applications.

UNIT-I

Fatigue and Statistical Aspects Of Fatigue Behaviour: S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves. Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques - Cumulative damage - Miner's theory - Other theories. **(14 hrs)**

UNIT-II

Physical Aspects Of Fatigue And Fracture: Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces - Strength and stress analysis of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - Effect of thickness on fracture toughness - stress intensity factors for typical geometries. **(10hrs)**

UNIT-III

Fatigue Design And testing: Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures. **(8hrs)**

UNIT-IV

Fundamentals Of Failure Analysis: Common causes of failure. Principles of failure analysis. Fracture mechanics approach to failure problems. Techniques of failure analysis. Service failure mechanisms - ductile and brittle fracture, fatigue fracture, wear failures, fretting failures, environment induced failures, high temp. failure. Faulty heat treatment and design failures, processing failures (forging, casting, machining etc.) **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References

1. Prasanth Kumar – “Elements of fracture mechanics” – Wheeter publication, 1999.
2. Barrois W, Ripely, E.L., “Fatigue of aircraft structure”, Pergamon press. Oxford, 1983.
3. Sin, C.G., “Mechanics of fracture” Vol. I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.
4. Knott, J.F., “Fundamentals of Fracture Mechanics”, Buterworth & Co., Ltd., London, 1983
5. Subra Suresh, “Fatigue of materials” , II edition, 1998.
6. T. L. Anderson, “Fracture mechanics: Fundamentals and applications”, III edition, 2004.

Course Outcomes

CO1: At the end of the course student will be able to understand the reasons behind the various types of failures of engineering materials.

CO2: They would understand the extent of loads the material will be able to withstand without failure.

CO3: Evaluate the performance of material under different loadings.

CO4: Select the suitable type of material considering the type of working conditions they are to withstand.

MEPE411: TWO-PHASE HEAT TRANSFER

Pre-requisite: Heat Transfer

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

The course "Two-Phase Heat Transfer" encompasses a wide range of topics, including modeling methods for one-dimensional two-phase flow, detailed modeling of interfacial flows, and the study of phase change phenomena. Its primary goal is to provide students with an understanding of the physics behind two-phase flows and equip them with analytical techniques to examine multiphase flows found in diverse industries such as chemical processing, space exploration, and food production. Additionally, the course delves into boiling heat transfer, which holds significance in applications like power plants and boilers.

UNIT-I

Introduction to multiphase flow, types and applications, Common terminologies, flow patterns and flow pattern maps. One dimensional steady homogenous flow, Concept of choking and critical flow phenomena, the separated flow model for stratified and annular flow. **(10 hrs)**

UNIT - II

General theory of drift flux model, Application of drift flux model to bubbly and slug flow, Pressure Drop in Two-Phase Flow. Measurement techniques for multiphase flow, void fraction and flow rate measurement. Description and Classification of Boiling, Pool Boiling Curve.

(10 hrs)

UNIT - III

Nucleation and Dynamics of Single Bubbles, Heat Transfer Mechanisms in Nucleate Boiling, Nucleate Boiling Correlations, Hydrodynamic of Pool Boiling Process, Pool Boiling Crisis, Film Boiling Fundamentals, Flow Boiling, Forced-Flow Boiling Regimes, Nucleate Boiling in Flow, Sub-cooled Nucleate Flow Boiling. **(10 hrs)**

UNIT - IV

Saturated Nucleate Flow Boiling, Flow Boiling Correlations, Flow Boiling Crisis. Film and dropwise condensation. Case studies/Latest developments/Sustainable technologies in two-phase heat transfer **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. Boiling Heat Transfer and Two-Phase Flow, L. S. Tong and Y. S. Tang, Taylor and Francis, 1997
2. Convective boiling and condensation, J. B. Collier, and J. R. Thome, Oxford Science Publications, 1994
3. C.E. Brennen, Fundamentals of Multiphase Flow, Cambridge University Press, New York, 2005.

Course Outcomes:

CO1: Understand the fundamentals of two-phase flow
CO2: Analyze flow regimes with appropriate models
CO3: Understand pool boiling and flow boiling
CO4: Estimate the two-phase heat transfer coefficients.

MEPC416: ENTREPRENEURSHIP AND START-UPs

Prerequisite: Nil

L	T	P	Credits	Total Contact Hours
3	-	-	3	42

Brief Description about the course

This course is designed to articulate students to

- Evaluate the business skills and commitment necessary to successfully operate an entrepreneurial venture and review the challenges and rewards of Entrepreneurship.
- Make Students learn about themselves, their decisions, and their goals to determine how entrepreneurship can play a role in their lives.
- Learn entrepreneurship from an economic perspective, the concepts of environmentally sustainable practices, social entrepreneurship and ability to recognize a business opportunity that fits their skill sets and recognize the critical importance of values and ethics when engaged in entrepreneurial activities
- Demonstrate the understanding of how to launch the individual's entrepreneurial career and to recognize the innate entrepreneurial potential within themselves.
- Recognize the critical importance of values and ethics when engaged in entrepreneurial activities.
- Make them aware and expose to latest policies of Government regarding Start-Ups and entrepreneurship.

UNIT-I

Engineering Economics: Definition and concept, Importance of economics for engineers, present value and future value, Wealth, Goods, Wants, Value and price, capital, money, utility of consumer and producer goods. Costing: Introduction, Elements of cost, Prime cost, Overhead, Factory cost, Total cost, Selling price, Nature of cost, Types of cost.
Depreciation: Definition and concept, Causes of depreciation, Methods of calculating depreciation. Economic analysis of investment and selection of alternatives: Introduction, Nature of selection problem, Nature of replacement problem, Replacement of items which deteriorate, Replacement of machines whose operating cost increase with time and the value of money also changes with time, methods used in selection of investment and replacement alternatives. **(10 Hrs)**

UNIT-II

Entrepreneurship: Entrepreneurship, Entrepreneurship Development, Characteristics and Qualities of an entrepreneur, some myths and realities about entrepreneurship, Functions of an Entrepreneur, Key Entrepreneurial skills, Creativity & Innovation, Entrepreneurial Opportunity Recognition Process, Business Ideas, Feasibility Studies, Business Plan
Small scale Industries: Introduction, Role and scope of small scale industries, concept of small scale and ancillary industrial undertakings, how to start a small scale industry, steps in launching own venture, various developmental agencies-their functions and role in industrial and entrepreneurship development, Infrastructure facilities available for entrepreneurship development in India. **(12 hrs)**

UNIT-III

Product Design: Introduction, Requirement of a good product design, Various controlling agencies involved -their role and formalities for getting clearance before starting individual venture. Concept Generation, Marketing: The modern concept of marketing, Definitions, functions and principle of marketing, STPD, 4Ps, Marketing –Tools with real time approach.

(10 hrs)

UNIT-IV

Start-Ups: Why a start-up, Types of Start-Ups, Characteristics of Start-Ups , Start-Up Ecosystem, Reasons for starting business, Concepts of TAM, SAM , MVP, GTM, PMF. AIDA model, Sales funnel, Team Building, Hiring. Knowledge about MCA policies regarding Start-Ups and role of various financial institutions, how to launch a company in India, Factors Entrepreneurs Consider while Launching a Start-up Raising Investments- Venture Capitalists, Angle Investors, Start-ups Best Practices, Some Examples of Startup Business Ideas and Successful Start-Ups, Techno-Economic feasibility project report, SWOT analysis. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text / Reference Books:

1. The practice of Entrepreneurship - By G. G. Meredikh, R.E. Nelson and P.A. Neck
2. Handbook of Entrepreneurship - Rao and Pareek
3. Entrepreneurship, 4e - Barringer,Pearson Publication
4. Entrepreneurship Development and Small Business Enterprises, - Charanthimath, Pearson Publication
5. Engineering Economics- Tarachand
6. Industrial Engineering and Management- Ravi Shankar
7. Industrial Engineering and Organization Management by S.K.Sharma and Sawita Sharma
8. Industrial Engineering and Management- O.P. Khanna

Course outcomes

CO 1: Ability to recognize a business opportunity that fits the individual skill-sets.
CO 2: Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career and find an attractive market that can be reached economically and create appropriate a business model.
CO 3: Apply effective written and oral communication skills to business situations.
CO 4: Analyze the global business environment, the local business environment and use critical thinking skills in business situations and develop an ethical understanding and perspective to business situations.

MEIC417: METROLOGY & MEASUREMENTS

Pre-requisite: **PT-II**

L	T	P	Credits	Total contact hours
3	0	0	3	42

Brief description about the course:

This course will introduce the students to the fundamental and advanced concepts related to the methods, standards, and instruments used in mechanical measurements. The students will be educated about measurement systems, performance characteristics, and errors in measurement. They will learn about various measuring equipment for engineering applications. The students will be familiarized with quality control terms and geometric features. Finally, the students will gain knowledge about the measurement of machine elements and advanced measuring machines.

UNIT-I

Fundamentals of Measurements: Measurement and its need, static & dynamic performance characteristics-linearity, resolution, threshold, precision, accuracy, hysteresis, speed of response, dead time and zone, frequency response, methods of measurements, generalized measurement system, errors & their classification, the concept of uncertainty, standards, Transducers. **(10 hrs)**

UNIT-II

Measuring Instruments for Mechanical Engineering: Linear measuring instruments- Calipers, Vernier Calipers, Vernier Height Gauge, Vernier Depth Gauge, Micrometers, angular measuring instruments- Protractors, Sine bars, Angle gauges, Spirit level & Clinometers, Comparators, measurement of force, torque, vibrations, pressure, temperature, strain, and flow. **(10 hrs)**

UNIT-III

Limits, Fits and Tolerances & Geometric Features: Introduction, Concept of interchangeability, Limits, tolerances, fits, gauges and design, the introduction of geometric features & their measurement- straightness, parallelism, flatness, roundness, circularity, eccentricity, applications, concept and measurement of surface roughness. **(10 hrs)**

UNIT-IV

Measurement of screw threads, gears and advanced measuring machines: Screw threads terminology, types of threads, measurement of screw threads, gear & its types, forms of gears, measurement of spur gear, Coordinate Measuring Machine (CMM), CMM probes and stylus, 3-dimension (3D) scanner and concept of reverse engineering. Case Study: Reverse Engineering of any mechanical component using CMM & 3D-scanner. **(12 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text/Reference Books:

1. T.G. Beckwith, R.D. Marangoni, “Mechanical Measurements”, Pearson.
2. A.K. Bewoor & V.A. Kulkarni, “Metrology and Measurements”, McGraw Hill Education.
3. N.V. Raghvendra & L. Krishnamurthy, “Engineering Metrology and Measurements”, Oxford Higher Education.
4. O.P. Khanna, “Metrology and Instrumentation”, Dhanpat Rai Publications.
5. R.K. Jain, “Engineering Metrology”, Khanna Publications.

Course outcomes

CO 1: Understand the basic concepts of measurements, errors, and standards of measurement.

CO 2: Understand and use measuring instruments for mechanical applications.

CO3: Understand the quality control key terms and measure the geometric and surface features of a machine element.

CO4: Be able to measure the screw threads and gears and get familiarized with the use of CMM and 3D scanners for advanced measurement.

MEIC426: METROLOGY & MEASUREMENTS (P)

Pre-requisite: **PT-II (P)**

L	T	P	Credits	Total contact hours
0	0	2	1	20

Brief description about the course:

This course will introduce the students to the instruments and experimental methods used in mechanical measurements. Precise linear and angular measuring devices will be discussed along with hands-on practice with advanced measuring machines. Students will learn the methods to conduct, analyze, interpret, and present measurement data from measurement experiments. Students will acquire excellent skills and techniques including the proper use of advanced measuring instruments.

Course Contents:

1. To measure the dimensions of a component using a Vernier calliper and micrometer.
2. To measure the angle of a component using a sine bar and bevel protractor.
3. To measure the elements of the screw thread and gears using a vision measuring microscope.
4. To measure the forces, temperature, pressure, and strain during the machining operation.
5. To measure the surface roughness of a machined surface using a surface profilometer.
6. Introduction to coordinate measuring machine (CMM) and its probe qualification.
7. Feature creation, base alignment, and basic measurements on CMM.
8. Flatness, taper, circularity, and roundness measurement on CMM.
9. Introduction of the 3D scanner and its calibration.
10. 3D scanning of parts and creation of STL file for rapid prototyping.

Course Outcomes:

By the end of this course:

1. The student shall be measuring the various parameters like length, height, angle, and displacement, by using various instruments like Vernier calipers, micrometer, dial indicator, bevel protractor, etc.
2. The student shall be able to measure the threads, gear tooth profiles, and surface roughness using appropriate instruments and analyze the data.
3. The student shall be able to measure the forces, temperature, pressure, and strain in mechanical engineering applications.
4. The student shall be able to check the dimensions and alignment of various components in various mechanisms using advanced measurement machines.

MEPE418: QUALITY CONTROL AND ASSURANCE

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

This course will present the theory and methods of quality and reliability monitoring including control charts, process capability, acceptance sampling and reliability based quality models etc. to give the participants necessary tools for the development of efficient statistical methods for assuring high quality in manufacturing sector.

UNIT - I

Introduction: definitions of quality, quality dimensions and aspects; concept of quality control and quality assurance, quality Gurus philosophies, basic quality control tools- old and new, Six Sigma, just-in-time, quality circle, variability concept in manufacturing cycle, fishbone diagram, charts in time philosophy. **(10 hrs)**

UNIT-II

Statistical Process Control: control charts and application, Type-1 and Type II errors, effect of control limits on errors, effect of sample size on control limits, sample size, Type of control charts- control chart for variable and attribute, different adaptations of control charts, manufacturing process variability, Process capability- process capability study using control charts and capability evaluation- C_p, C_{pk} and P_p, P_{pk}. **(10 hrs)**

UNIT-II

Acceptance Sampling: Operating Characteristic Curve (O-C curve); Effect of sample size and acceptance number, Single, Double and Multiple Sampling Plans, Acceptance/ rejection and acceptance/ rectification plans. Producer's risk and consumer's risk. Indifference quality level, Average Outgoing Quality (AOQ) curve, AOQL. Quality protection offered by a sampling plan. Average Sample Number (ASN) curve, Average Total Inspection (ATI) curve, design of single sampling plans. **(10 hrs)**

UNIT-IV

Reliability: Concepts of reliability in quality, product quality based Bath tub curve, Mean Time to Failure, reliability in series and parallel configuration of a product, effect of redundancy in reliability, method of reliability evaluation, availability and maintainability concepts.

Sustainable practices in quality assurance, case studies for improving product and service quality, total quality management, ISO 9000, application of RCA and FMEA for sustainable product operation. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Grant E L and Leavenworth R S, “Statistical Quality Control”, McGraw Hill, Sixth Edition (2000)
2. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Pearson Education Asia, Third Edition (2014)
3. Douglas C. Montgomery “Introduction to Statistical Quality Control”, John Wiley & Sons, Inc., New York, 7th Edition (2013)
4. Srinath L S “Reliability Engineering”, Affiliated East-West Press Limited, New Delhi, 2002.

Course Outcomes

CO1: Students will learn the fundamentals of quality management.

CO2: Students will be able to understand the basic statistical concepts based control charts.

CO3: Students will be able to understand acceptance sampling and sampling Plans based concepts and applications.

CO4: Students will understand the reliability and its relationship with quality.

MEPE419: SIX SIGMA CONCEPTS AND METHODOLOGY

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

Six Sigma is a best in class process improvement strategy that focuses on reducing process variation in business operations. It aims to achieve operational excellence by minimizing defects and waste in the system. This course can provide the general procedure and framework to understand and implement the six sigma in any organization.

UNIT-I

Quality concepts, evolution of continuous improvement, concept of six sigma, need for six sigma, process yield, statistical rationale of six sigma, belt system, teams, leadership in six sigma, resources for Six Sigma, roles and responsibilities of six sigma professionals. **(8 hrs)**

UNIT-II

Six Sigma Strategy: Six sigma strategic planning, define measure analyze improve control (DMAIC), design for six sigma (DFSS), selection of six sigma toolset, enablers of six sigma, obstacles of six sigma. **(10 hrs)**

UNIT-III

Six Sigma Project Implementation: Implementation framework, Define: project identification, project selection, problem definition, voice of customer, project critical to quality, improvement opportunity, process mapping, Measure: six sigma metrics, critical process assessment, measure metrics, Analyze: source of variations, analyzing root causes, Improve: six sigma improvement, implementation planning, innovate solution, selecting a solution, piloting the solution, improvement evaluation, lean process improvement, Control: need of control and monitoring in six sigma project, out of control action plan. **(14 hrs)**

UNIT-IV

Six Sigma for Operational Excellence: combining lean and six sigma methodologies, sustainable six sigma, integration with industry 4.0, tangible gains of six sigma, impact on organization sustainability, six sigma case studies: manufacturing sector, healthcare, higher education, supply chain management. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. An introduction to six sigma and process improvement by james r. evans & william m. lindsay, cengage learning
2. Six sigma handbook by thomas pyzdek, paul a. keller, mc graw hill
3. Six sigma the breakthrough management strategy revolutionizing the world's top corporations
4. Six sigma for business excellence: approach tools and applications by hemant urdhwareshe, pearson

Course Outcomes

CO 1: Understand the basics of six sigma and role of teams in six sigma execution
CO 2: Interpret the six sigma implementation strategy for manufacturing and service sector
CO 3: Apply six sigma DMAIC process to reduce process variations
CO 4: Relate the sustainable and smart process improvement practices with conventional strategies

MEPE420: TOTAL QUALITY MANAGEMENT

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Total Quality Management is a business improvement strategy to management that focuses on continuous improvement, customer satisfaction, and the involvement of all employees in the organization. This course provides a holistic and comprehensive management philosophy that aims to enhance the quality of products, services, and processes within an organization.

UNIT-I

Introduction: Products and services, quality and productivity, dimensions of quality: manufacturing and service, continuous improvement**,** quality management practices, need of TQM, concept of TQM, elements of TQM, pillars of TQM, companywide organization for quality management, quality awards. **(8 hrs)**

UNIT-II

TQM Leadership and Techniques: Motivation and involvement for total quality, strategic quality planning, corporate culture, total employee involvement, total commitment, role of information in total quality, soft and hard practices of TQM, quality circle, seven QC tools, failure mode effect analysis, gemba kaizen, 6S, benchmarking, zero defects, PDCA cycle. **(12 hrs)**

UNIT- III

TQM Framework and Systems: Success factors and obstacles in TQM implementation, Implementing TQM, TQM framework, quality management systems; ISO 9000 Series of standards, ISO 9001 structure, ISO 14000 series standards, concepts of ISO 14001, requirements and benefits of ISO 14001. **(12 hrs)**

UNIT-IV

TQM Case and Sustainable Practices: Sustainable TQM, TQM 4.0, lean-TQM, total productive maintenance, TQM case studies in manufacturing and service sector. **(8 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Besterfield, D.H, Michna, C.B, Besterfield, G. H and Sacre, M.B, “Total Quality Management” Pearson Education Asia.
2. Mukherjee, P. N., “Total Quality Management” Prentice Hall of India.
3. Rajaram, S., “Total Quality Management” Biztantra.
4. Ramasamy, S. “Total Quality Management” Mc Graw Hill Education.

Course Outcomes

CO 1: Understand the fundamentals of quality management practices.
CO 2: Discuss the need of customer expectations, employee involvement and supplier partnership.
CO 3: Apply the TQM tools and techniques to improve the product and process quality.
CO 4: Describe quality Management system standards and certification process.

MEPE421: FACILITIES DESIGN

Pre-requisite: Industrial Engg.

L	T	P	Credits	Total contact hours
3	-	-	3	40

Brief Description about the course

Facility planning is a process in which, the needs of specific facility are identified. This course will help student to understand the main concepts of Plant Location and apply them to know about the practical aspects of Industrial World. The learning objectives of this course are: to understand main fundamentals and applications of Facility Planning as well as concept of line balancing. Facility planning impart thorough knowledge to the students regarding evaluating, preparing and maintaining the facilities plan. This course is informative for the student regarding concepts of Engineering Economics and Industrial Acts & Safety.

Unit-I

Plant Location: Nature of Location Decision, Need for facility location planning, General procedures and actors influencing location decisions, Facility Location Models, economics and cost analysis, Rural and urban location pattern in India.

(10 hrs)

Unit-II

Facility Planning: Definition, Significance and objectives of facility planning, Facility planning process, Strategic Facilities Planning, Developing Facilities Planning Strategies, Flow system patterns like RAFT, CORELAP, ALDEP & PLANET, Material flow system, Activity Relationships, Space requirements, Basic Lay out types, Lay out procedures, Algorithmic Approaches, Department Shapes and mail Aisles, The impact of changes, developing Layout Alternatives. **(10 hrs)**

Unit-III

Evaluating, Preparing, Maintaining the Facilities Plan & Line Balancing: Introduction, Evaluating, selecting, preparing, presenting, implementing and maintaining the Facilities Plan. Line Balancing**:** Definitions, heuristic and analytical methods of balancing the assembly and production line, single and mixed model line balancing, alternatives to line balancing.

(10 hrs)

Unit- IV

Industrial Acts and Safety: Necessity of Industrial acts, The Indian Factories Act 1948, The industrial Dispute act1947, The minimum Wage Act 1948. Introduction to Industrial safety, Causes and sources of accidents, Accident control, safety program investigation and analysis of accidents, Safety devices in Machines, Welfare and safety, safety and productivity.

Engineering Economics: Concept of Engineering economics, Risk and uncertainty, discounted cash flow techniques in changing economics, Purpose, type and requirements of depreciation methods and obsolesce, Reasons for replacement and it's models, Present worth method of comparison and future worth methods, Welfare and safety, safety and productivity**.**

(10 hrs)

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text/Reference Books

1. James A.Tompkins.,"Facilities Planning".Edition 3, publisher J.Wiley 2003.

2. James Apple, “Plant Layout & Material Handling”, The Ronalt Press Co. , New Delhi, 1998.
3. Richards Muther,”Practical Plant Layout”, McGraw Hill Book Co., New York, 1982.
4. Francis, R.L., McGinnis, L.F., and White, J.A.,“Facility Layout and Location: An Analytical Approach”, Prentice Hall of India, 2004.
5. Sule,D.R.,“Manufacturing Facilities-Location, Planning, and Design”, PWS Publishing Company, 1984.

Course Outcomes:

CO 1: The students will be able to Rural and Urban location pattern in India.
CO 2 : The students will be able to understand Developing Facilities Planning Strategies.
CO 3 : The students will be able to Basic Lay out types in line balancing.
CO 4 : The students will be able to understand the various Necessity of Industrial acts.
CO 5 : The students will be able to understand the concepts of Engineering economics, Welfare and Safety.

MEPE423: THERMAL DESIGN AND MANAGEMENT OF ELECTRONIC EQUIPMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course

We live in an era dominated by information, where electronic technology plays an essential role in our daily lives. The electronics industry has experienced remarkable growth in recent years, evident in the widespread presence of electronic products in various aspects of our existence. With the ever-increasing demand for faster and larger information transmission, communication, and processing, electronic devices are prone to generating more heat. In order to meet this escalating demand, it becomes crucial for us to continually explore approaches that enable early adoption of new and emerging thermal technologies, enhance quality and reliability, and reduce costs. It is now widely acknowledged that the performance and cost of an electronic system are primarily constrained not by advancements in device and chip technology alone, but by our ability to effectively package these individual chips into modules, boards, subsystems, and complete systems.

UNIT - I

Introduction– importance of thermal management of electronics, temperature effects on different failure modes; Basics of conduction, convection, radiation heat transfer. **(10 hrs)**

UNIT - II

Cooling methods used in the industry for electronics–conduction cooling, cooling by heat sinks– design aspects of heat sinks, convection cooling, selection of fan, liquid immersion cooling, cold-wall cooling, cold plates, jet impingement cooling, synthetic jet cooling, thermoelectric or solid state coolers, radiative heat transfer and importance in space applications. **(10 hrs)**

UNIT - III

Cooling using phase change– cooling with PCM materials, micro/mini channel cooling, contact resistance, cooling using heat pipes– working principle, selection of heat pipe working fluid; Selection of cooling technique– ranges of cooling rates of different cooling methods, selection criteria. **(12 hrs)**

UNIT – IV

Experimental techniques used for thermal measurements; Reliability issues: importance, bathtub curve. Case studies/Latest developments/Sustainable technologies in thermal design and management of electronic equipment. **(08 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Textbook and References:

1. Younes Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press Inc, 2010.
2. Dave S. Steinberg, Cooling Techniques for Electronic Equipment, Wiley, 1991.
3. Sung Jin Kim, Sang Woo Lee, Air Cooling Technology for Electronic Equipment, Taylor & Francis, 1996.
4. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill, 2001.
5. Yunus A. Cengel, Heat Transfer: A Practical Approach. McGraw-Hill, 2003.

Course Outcomes:

CO1:be able to appreciate the applicability of heat transfer first principles to electronics cooling.
CO2:raise awareness of the need for energy efficiency in cooling of electronic systems.
CO3:be equipped with tools to approach existing industry applications
CO4:be able to evaluate emerging thermal management techniques.

MEPE424: AUTOMOBILE ENGINEERING

Pre-requisite: ICGT

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

This course provides an introduction to vehicle structure, engine, automotive electric and electronic systems, automotive drive trains, steering system, brakes and suspension systems; it also provides an introduction to engine emissions and their control and offers various alternative fuels that can be used in automobiles

UNIT-I

Introduction to Automobile Engineering: Importance, applications, job opportunities, classification, types of vehicles, basic structure, general layout, and hybrid vehicles.
Automotive Electric and Electronic Systems: Electric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles. **(10 hrs)**

UNIT-II

Automotive Drive Trains:
Clutches: Requirements and principle of clutches, dry friction clutches, clutch components, types of clutches-single plate, multi plate, semi centrifugal and centrifugal, clutch operation, wet clutch, clutch dynamics, Clutch trouble shooting.
Transmission: Necessity & functions of transmission, types of transmission, sliding mesh gear box, constant mesh gear box, synchromesh gear box, selector mechanism, transfer box, automatic transmission, epicyclic gear box, principle of automatic transmission, Driveline dynamics: Engine Dynamics, Driveline & Efficiency, Gearbox dynamics.
Propeller Shaft and Rear Box: Propeller shaft, universal joints, final drive, differential, rear axle, rear axle drives, rear axle casing, improvements in four wheel drive. **(12 hrs)**

UNIT-III

Steering, Brakes and Suspension Systems: Wheels and Tyres; Steering system: Steering Geometry, camber, castor, king pin, rake, combined angle toe-in, toe-out, types of steering mechanism, Ackerman steering mechanism, Davis steering mechanism, steering gears types, steering linkages, Power Steering, Braking system: Mechanical brake system, Hydraulic brakes system, Master cylinder, wheel cylinder, Requirements of brake fluid, pneumatic and vacuum brake, Antilock Braking System (ABS); Suspension System: Need of Suspension System, Types of Suspension, Suspension Springs, Constructional Details and Characteristics of Leaf, Coil and Torsion Bar Springs, independent Suspension, Rubber Suspension, Pneumatic Suspension, Shock Absorbers.
(12 hrs)

UNIT-IV

Emissions from Automobiles: Emissions from automobiles, pollution standards national and international, pollution control techniques, petrol injection, common rail diesel injection, variable valve timing; Energy alternatives, solar, photovoltaic, hydrogen, biomass, alcohols, LPG, CNG, liquid fuels and gaseous fuels, hydrogen as a fuel for internal combustion engines, their merits and demerits.

(6 hrs)

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The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/References:

1. Kirpal Singh, “Automobile Engineering Vol. I & II”, Standard Publishers, New Delhi, 2011.
2. Tom Denton, “Automobile Electrical and Electronics Systems”, Butterworth-Heinemann (2003).
3. William H Crouse & Anglin D L "Automotive Mechanics", Tata McGraw Hill Publishing Company., 2006
4. Joshep Heitner, “Automotive Mechanics”, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2004.
5. R.B. Gupta, “Automobile Engineering”, Satya Prakashan Publisher, New Delhi.

Course Outcomes:

At the end of course, the students will be able to:
CO1: Understand the concept of various vehicle structure and identify the usage of electrical and hybrid vehicles.
CO2: Analyze the working principles and operations details of clutches and transmission systems.
CO3: Evaluate the operational details and design principles of steering, braking and suspension systems.
CO4: Compare the effects of emissions from automobiles. And to know the ways and means of reducing emissions.

MEPE425: INDUSTRIAL ROBOTICS

Pre-requisite: **DoM**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course will introduce the students to the fundamentals of robot design and hence, the learning objectives of this course are:

- To understand the basic concepts related to robot anatomy, classification and industrial applications of manipulators.
- To understand direct, inverse and differential kinematics of robot manipulator.
- To understand static and dynamic modeling of robot arm.
- To understand control of manipulators.

UNIT – I

Introduction to Robotics

Evolution of Robots and Robotics, Types of Automation, Robot anatomy, Classification of robots based on drive technologies, workspace geometry and motion, control systems; Robot specifications; Industrial applications of robots

Coordinate Frames, Mapping and Transforms

Coordinate Frames, Description of objects in space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation matrices. **(10 hrs)**

UNIT – II

Direct Kinematic Model

Mechanical structure and notations, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation, Manipulator Transformation Matrix.

The Inverse Kinematics

Manipulator workspace, solvability of Inverse kinematics model, solution techniques, closed form solution. **(10 hrs)**

UNIT – III

Manipulator Differential Motion and Statics

Linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian Inverse, Jacobian Singularities, Static Analysis.

Dynamic Modeling

Lagrangian Mechanics, Two Degree of Freedom manipulator-Dynamic Model, Lagrange-Euler formulation Newton-Euler formulation, Inverse Dynamics. **(10 hrs)**

UNIT – IV

Control of Manipulators

Open and Close loop control, linear control schemes, linear second order SISO model of a manipulator joint. Actuator dynamics; Set point tracking: Performance of PID, controller.

Case Studies

For Microrobot Alpha-II and 5-axis Articulated Robot Rhino XR3, assign link frames and list kinematic parameters using D-H algorithm; formulate arm matrices and develop a computer code to simulate the end-effector motion for a given range of joint diplacements; solve for joint displacements for a set of end-effector position and orientation; study the effect of link dimensions on end-effector trajectory; formulate the Jacobian and determine actuator torques for a given end-effector force vector (10 hrs)

NOTE:

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Text Books / Reference

1. Fundamental of Robotics by Robert J. Sehilling Prentice Hall of India.
2. Introduction to Robotics by Saeed B. Niku Pearson Education Asia.
3. Robot Modeling and kinematics by RachidManseur, Luxmi Publications.

Course Outcomes

CO 1: Understand the concept of Industrial Robotics and its applications

CO 2: Understand the coordinate transformations between fixed and mobile frames and solve design problems involving direct, inverse and differential Kinematics

CO 3: Formulate and solve static and dynamic models of Robot Arms.

CO 4: Understand robot control actuator dynamics as well as evaluate the performance of PID controller for set point tracking.

List of Open Electives to be offered by Mechanical Engineering Department

Odd Semester		Even Semester	
CODE	**COURSE**	**CODE**	**COURSE**
MEOE427	**Reliability & Maintenance Engineering**	**MEOE431**	**Nuclear Engineering**
MEOE428	**Total Quality Management**	**MEOE432**	**Renewable Energy Systems**
MEOE429	**Logistics & Supply Chain Management**	**MEOE433**	**Engineering Economy**
MEOE430	**Industrial Engineering and Management**	**MEOE434**	**Thermal Design and Management of Electronic Equipment**

MEOE427: RELIABILITY AND MAINTENANCE ENGINEERING

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief Description about the course

This course will be useful in developing student's skill related to current maintenance practices and advanced maintenance issues handling in small and heavy process industries. The course imparts the theoretical and analytical skill based knowledge about maintenance practices in different Industries/plants. Various reliability based maintenance models with their industrial application are also covered under this course.

UNIT - I

Reliability based maintenance engineering: Introduction to Probability concepts, RAM aspects in maintenance, Failure Distribution- Reliability function, CDF and PDF, hazard rate function, Bath tub curve for industrial repairable system, conditional reliability concept in maintenance, Exponential, Weibull, normal and lognormal distributions based maintenance models. System reliability determination: Series –parallel system reliability, Type of redundancy, k out of n standby system, redundant standby systems, system structure functions, minimal cuts and minimal paths.

State- Dependent system- Markov analysis for system availability: load sharing system, stands by systems, degraded systems **(10 hrs)**

UNIT – II

Maintenance introduction and overview: Maintenance definition, objectives and importance of maintenance, functions of maintenance: basic functions and composite functions, primary and secondary functions.

Maintenance strategies: Definition of maintenance strategy, Classification of maintenance strategies, other maintenance strategies, advantages and disadvantages of maintenance strategies.

Total Productive Maintenance: TPM Definition, Principles, TPM VIS-A-VIS Terro-Technology, Pillars of TPM, TPM implementation in industry. **(10 hrs)**

UNIT – III

Maintenance Planning and scheduling: Maintenance planning and scheduling types and techniques, short and long term planning.

Condition monitoring: Condition signals and monitoring, condition monitoring techniques: Performance monitoring, temperature monitoring, thermography, leakage monitoring, vibration monitoring, lubricant monitoring, ultrasound monitoring, corrosion monitoring, Motor current signature analysis (MCSA).

Maintenance Effectiveness, indices and audit: OEE, Equipment availability, maintenance effectiveness assessment, KPI, maintenance performance measuring indices.

(10 hrs)

UNIT – IV

Case Studies with Application: Application of RCA, FMEA and FMECA tools for industrial maintenance, Design of fuzzy MATLAB tool box based FMEA decision support system for maintenance action, Fault tree and PN diagram based availability analysis, Maintenance

decision making models with industrial application. **(10 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books / Reference

1. Kelly A., "Maintenance Planning and Control", Butterworth-Heinemann.Ltd, London.
2. Cliffton R. H.,"Principle of Planned Maintenance", McGraw Hill Inc. New York
3. Charles E. E., "An Introduction to Reliability and Maintainability Engineering", McGraw Hill Education,New York, 2017.
4. Dhillon B S, "Engineering Maintainability", Prentice Hall of India, New Delhi, 2000.
5. Wireman Terry, "Preventive Maintenance", Reston Publishing Company, Reston Virginia, 1998

Course Outcomes

CO 1: Student will be able to learn various reliability concepts and its implementation in industry.

CO2: Students will be able to develop reliability based mathematical modeling for industrial system.

CO 3: Students will gain knowledge related to maintenance objective/functions and TPM.

CO 4: Students will be able to learn how to plan & schedule the maintenance job.

CO 5: Students will learn about various CM techniques and their implementation.

CO 6: Students will become capable to implement various maintenance tools in industry.

MEOE428: TOTAL QUALITY MANAGEMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Total Quality Management is a business improvement strategy to management that focuses on continuous improvement, customer satisfaction, and the involvement of all employees in the organization. This course provides a holistic and comprehensive management philosophy that aims to enhance the quality of products, services, and processes within an organization.

UNIT-I

Introduction: Products and services, quality and productivity, dimensions of quality: manufacturing and service, continuous improvement**,** quality management practices, need of TQM, concept of TQM, elements of TQM, pillars of TQM, companywide organization for quality management, quality awards. **(8 hrs)**

UNIT-II

TQM Leadership and Techniques: Motivation and involvement for total quality, strategic quality planning, corporate culture, total employee involvement, total commitment, role of information in total quality, soft and hard practices of TQM, quality circle, seven QC tools, failure mode effect analysis, gemba kaizen, 6S, benchmarking, zero defects, PDCA cycle. **(12 hrs)**

UNIT- III

TQM Framework and Systems: Success factors and obstacles in TQM implementation, Implementing TQM, TQM framework, quality management systems; ISO 9000 Series of standards, ISO 9001 structure, ISO 14000 series standards, concepts of ISO 14001, requirements and benefits of ISO 14001.
(12 hrs)

UNIT-IV

TQM Case and Sustainable Practices: Sustainable TQM, TQM 4.0, lean-TQM, total productive maintenance, TQM case studies in manufacturing and service sector. **(8 hrs)**

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Text Books / Reference

1. Besterfield, D.H, Michna, C.B, Besterfield, G. H and Sacre, M.B, “Total Quality Management” Pearson Education Asia.
2. Mukherjee, P. N., “Total Quality Management” Prentice Hall of India.
3. Rajaram, S., “Total Quality Management” Biztantra.
4. Ramasamy, S. “Total Quality Management” Mc Graw Hill Education.

Course Outcomes

CO 1: Understand the fundamentals of quality management practices.
CO 2: Discuss the need of customer expectations, employee involvement and supplier partnership.
CO 3: Apply the TQM tools and techniques to improve the product and process quality.
CO 4: Describe quality Management system standards and certification process.

MEOE429: LOGISTICS & SUPPLY CHAIN MANAGEMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
03	00	00	03	40

Brief Description about the course

To understand concept of Supply chain management and apply this knowledge to understand the working of corporate world.

Unit-I

Understanding the Supply Chain, Performance, Drivers and Obstacles: Objectives of supply chain, Stages of supply chain, Supply chain process cycles, Push/pull view of supply chain processes, Importance of supply chain flows, Examples of supply chain, Strategic decisions in supply chain management. Supply Chain Performance, Supply chain strategies, achieving strategic fit, Product life cycle, Supply Chain drivers and Obstacles, four drivers of supply chain – inventory, transportation, facilities, and information, Obstacles to achieve strategic fit.

(10 hrs)

Unit-II

Planning Demand and Supply in a Supply Chain: Role of forecasting in a supply chain, Forecasting methods in a supply chain, Basic approach to demand forecasting, Aggregate planning resources. Managing economies of scale in a supply chain, Role of cycle inventory in a supply chain. **(10 hrs)**

Unit-III

Transportation and Coordination in a Supply Chain: Facilities affecting transportation decisions, Transport selection, Modes of transportation and their performance characteristics, Trade-offs in transportation decision, Making transportation decisions in practice, Models for transportation and distribution, Third party logistics (3PL). Coordination in a Supply chain, Lack of supply chain coordination and the Bullwhip effect, Effect of lack of coordination on performance, Obstacles to coordination, Achieving coordination in practice.

(10 hrs)

Unit-IV

Source Management and IT in Supply Chain: Inventory management in supply chain, Information technology in supply chain, Typical IT solution, Reverse supply chain, Reverse supply chain Vs. Forward supply chain

Advanced topics in SCM: Green, Lean, Sustainable, Global and Agile supply chain Management, Quality in Supply Chain. Integration and Collaborative Supply Chain, Circular Supply Chain Management.

Cases in Supply Chain: Case Studies such as Newspaper, Mumbai Tiffanwala, Disaster Management, Organic Food, Fast Food, Hostel Mess etc. **(10 hrs)**

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Text/Reference Books:

1. Christopher Martin, "*Logistics and Supply Chain Management*", Pearson Education Asia.
2. Chopra Sunil and Meindl Peter, "*Supply Chain Management – Strategy, planning and operation's"*, Pearson Education, Asia.
3. Kapoor K K, KansalPurva, "*Marketing logistics: A Supply Chain Approach*", Pearson Education Asia.
4. Mohanty, R.P and Deshmukh, S.G., "*Supply Chain Management*", Pearson Education Asia.
5. Fawcett, S. E., Ellram, L. M and Ogden, J. A., "Supply Chain Management" Pearson Education Asia.
6. Dixit Garg, Sunil Luthra and Sachin Mangla., "Supply Chain and Logistics Management". New Age International Publishers

Course Outcomes:

CO 1: Understand the decision phases and apply competitive & supply chain strategies.
CO 2: Understand drivers of supply chain performance.
CO 3:. Analyze factors influencing network design and forecasting in a supply chain.
CO 4: Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

MEOE430: INDUSTRIAL ENGINEERING AND MANAGEMENT

Pre-requisite:**Nil**

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

Industrial Engineering Management course focuses on optimizing complex systems and processes in various industries. It combines engineering principles with business management techniques to improve overall productivity and performance. Industrial engineers analyze and evaluate various factors, and manage business/industrial systems involving people, materials, methods, and machines.

UNIT-I

Definition, role, and scope of industrial engineering, industrial engineering approach and techniques, principles of organization, elements of organization, types of organization.

Plant layout, site selection, types of plant layout, factors affecting layout, plant building, flexibility and expansion. **(8hrs)**

UNIT-II

Materials Management: Introduction, inventory, inventory costs, inventory cost relationship, inventory control models, ABC analysis MRP, elements of MRP.
Work study: Method study, method study techniques, work measurement techniques, time study, observed time, basic time, normal time, allowances, standard time.

(10 hrs)

UNIT III

Sales Forecasting Introduction, objectives of sales forecasting, types of forecasting, methods of sales forecasting; collective opinion method, Delphi technique, moving average method, time series analysis, simple exponential smoothing, measurement of forecasting errors.

Quality Management: Quality, dimensions of quality, quality control, basic QC tools, introduction to statistical quality control, quality assurance six-sigma introduction. **(12 hrs)**

UNIT-IV

Basics of project management, network analysis, Critical path method, Program evaluation and review technique, Comparison between CPM and PERT

Advancement in Industrial Management: Industry 4.0, lean management, sustainable industrial practices, case studies pertains to advanced industrial practices. **(10 hrs)**

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Text Books / Reference

1. Production and operations management by S.N.Chary Publication Tata Mc Graw Hill (TMH)
2. Industrial Engineering and Organization Management by S.K. Sharma & Savita Sharma Publication Kataria & sons
3. Industrial Engineering and Production management by Martland T Telsang Publication S. chand
4. Modern Production Management by Elwood S. Buffo Rakesh K. Sarin Publication John Wiley & Sons
5. Jocobs, C.A., “Production and Operations Management”, Tata McGraw Hill
6. Handbook of Industrial Engineering: Technology and Operations Management, by Gavriel Salvendy, publication John Wiley & Sons
7. Mitra, A., “Fundamentals of Quality Control and Improvement”, John Wiley & Sons, Inc.

Course Outcomes

CO1: Understand industrial engineering concepts to optimize the industrial resources
CO2: Use plant layout concepts to develop and expand the industrial layouts.
CO3: Apply forecasting and materials management for smooth functioning of industry on shop floors
CO4: Analyze the quality of product and services in industrial scenario with concept of quality management

MEOE431: NUCLEAR ENGINEERING

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	-	-	3	40

1. **Concepts of Nuclear Physics:** The atom, structure, the nucleus, nuclear structure, atomic transmutation of elements, detection of radio-activity, particle accelerator, decay, natural of elements, nucleus interactions, decay rates, half-life, transuranic elements. **(6hrs)**
2. **Neutorn Interaction:** Advantages of using neutron, neutron moderation, fission chain reaction, thermalisation of neutrons, fast neutrons, prompt and delayed neutrons, fission products. **(4hrs)**
3. **Energy Release:** Mass energy equivalence, mass defect, binding energy, energy release in fission & fusion, thermonuclear reaction, fusion bomb. **(4hrs)**
4. **Reactor Materials:** Fissile & fertile materials, cladding & shielding materials, moderators, coolants. **(4hrs)**
5. **Reactor Technology:** Basic principles, fuel assembly, neutron balance, reactor kinetics, reactor coefficients, reactor stability, excess reactivity, Xenon poisoning, burnable absorbers, reactivity control, heat balance, production& transfer of heat to the coolant, structural considerations. **(10 hrs)**
6. **Nuclear Reactors:** Types of nuclear reactors, pressurized water reactors, boiling water reactors, CANDU type reactors, gas cooled & liquid metal cooled reactors, fast breeder reactors. **(6hrs)**
7. **Safety Considerations & Waste Disposal:** Hazards, plant site selection, safety measures incorporated in; plant design, accident control, disposal of nuclear waste. **(4hrs)**
8. **Health Physics & Radio-isotopes:** Radiation: units, hazards, prevention, preparation of radio-isotopes& their use in medicine, agriculture & industry. **(2hrs)**

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Text Books/References:

1. M. M. El-Wakel, Nuclear Power Engineering, McGraw Hill
2. Shultis and Faw, Fundamentals of Nuclear Science and Engineering, CRC Press
3. Stephenson, Introduction to Nuclear Engineering, McGraw Hill
4. Murray, Nuclear Energy, Butterworth-Heinemann.

Course Outcomes:

CO1: To understand the concepts of neutron physics and various nuclear Processes involved in Nuclear Power Plants.
CO2: To calculate heat generation from nuclear reaction.
CO3: To design and analyze the performance of nuclear power plants.
CO4: To get acquainted with applications of radioactivity.
CO5: To appreciate the hazards associated with radioactivity and the necessity of waste disposal.

MEOE432: RENEWABLE ENERGY SYSTEMS

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	40

Brief description about the course

The main purpose of this course is to introduce students with conventional and Renewable energy sources environmental impacts, challenges and future trends, fundamentals, potential, estimation and, applications: Solar Energy, Wind Energy, Hydropower, Biomass, Geothermal Energy, Ocean Energy. The Renewable energy resources availability, potential and suitability as a substitute for conventional energy resources in future energy demand. Having completed the courses, the student should have Knowledge about different renewable energy resources. Advanced knowledge about potential of using renewable energy technologies as a complement to and to the extent possible, replacement for conventional technologies, and possibilities to combining renewable and non-renewable energy technologies in hybrid systems.

UNIT - I

Forms of Energy, Nuclear energy, Hydro energy, Renewable energy, Energy demand, Energy statistics, Comparison of fuels such as wood, charcoal, coal, kerosene, Diesel, petrol, furnace oil, LPG, biogas and electricity on calorific value and cost basis, Efficiencies of various Energy production methods. Ministry of Power, Ministry of New and Renewable Energy, Energy Auditing and Management, Energy Conservation Act, Bureau of Energy Efficiency, Schemes and policies of PCRA. **(08 hrs)**

UNIT – II

Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications. Solar Collectors, Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Flat-plate collectors: types; Thermal analysis; Thermal drying. Selective surfaces - Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization. **(10 hrs)**

UNIT – III

Energy Generation from wastes: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments – types of digesters –factors affecting bio-digestion - Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in municipality and medical. **(12 hrs)**

UNIT – IV

Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. – Site Selection Criteria – Advantages – Limitations – Wind Rose Diagram – Indian Wind Energy Data – Organizations like C-WET etc., Wind Energy Conversion System - Design - Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction. **(10 hrs)**

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Text Books / References:

1. Renewable Energy Sources by Twidell & Weir, Taylor and Francis, 2nd Special Indian Edition.
2. Non-conventional Energy Sources by G.D. Rai, Dhanpat Ral and Sons.
3. Renewable Energy Resources by Tiwari and Ghosal, Narosa.

Course Outcomes:

CO 1: Understanding of commercial energy and renewable energy sources.
CO 2: Knowledge in working principle of various energy systems.
CO 3: Capability to do basic design of renewable energy systems.
CO 4: Upon completion of this course, the students will be able to identify the new Methodologies / technologies for effective utilization of renewable energy sources.

MEOE433: ENGINEERING ECONOMY

Pre-requisite: **Nil**

L	T	P	Credits	Total contact hours
3	0	0	3	42

Brief description about the course

Engineering Economy covers to an extensive view of engineering design and manufacturing products of cost analysis and also economic issues overcomes by understanding of linear & balance depreciation feasibility decisions. The proposed course to target the basics of engineering economy domains and scopes. The following learning objectives are subjected such as the basic concepts of the time value of money and economic equivalence, different cash flows and operational and maintenance costs, and different economic analysis methods. The study will also help to learn the break-even cost analysis, replacement decisions of products (life cycle) and specific system, adoption of new sustainable economy practices such circular economy, green economy in manufacturing environments.

UNIT-I

Introduction: The fundamental concepts and objectives of engineering economy, function and uses of engineering economy, Types of engineering economic decision & roles, physical and economic laws, and flow of economy, consumer and producer goods.

Interest and Annuity Relationships: Productivity of capital, nominal and effective interest, interest factors, CAF, PWF, SPWF, SCAF, SFF, and CRF, deferred annuities, perpetuities and capitalized cost, equivalence, gradient factors, GPWF and GUSF. **(10hrs)**

UNIT-II

Depreciation Methods: Define the term of depreciation, types of depreciation & methods of computing depreciation, economic life and mortality data, capital recovery and return. Element of costing: Types of cost , Classification of costs: Direct material, direct labour and overheads, fixed and variable cost, semi-fixed cost, increment, differential and marginal cost, sunk cost and its reasons, direct and indirect cost, prime cost, factory cost, production cost and total cost. **(12hrs)**

UNIT-III

Cost Analysis: Types of cost analysis, Break-even analysis, two and three alternatives, graphical solution, break-even charts, effects of changes in fixed and variable cost, minimum cost analysis, economic order quantity, effect of risk and uncertainty on lot size. Replacement Analysis: Reason of replacement, evaluation of proposals, replacement because of inadequacy, excessive maintenance, declining efficiency, obsolescence, MAPI formula.

(10hrs)

UNIT-IV

Cost Estimation: Difference between cost estimation and cost accounting, qualifications of an estimator, estimating procedure, estimate of material cost and labour cost, estimate of cost in machining, forging, welding and foundry operations.

Sustainable Economy: Basic economy study patterns and their comparison, effect of taxation on economic studies. Sustainable economies: Types of sustainable economies, sustainable economy, circular economy.

(10hrs)

NOTE:

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Text Books / Reference:

1. Leland Blank, Anthony Tarquin; Engineering Economy, McGrawhill Education (India), New Delhi, 2017.ISBN13: 978-1-25-902740-6
2. William G. Sullivan, C. Patrick Koelling; Engineering Economy, Pearson Education (Asia), 2017.
3. Grant, E.L., Grant, W., and Leavenworth, R.S., Principles of Engineering Economy, John Wiley & Sons, 2015.
4. Eschenbach , T.G., Engineering Economy by Applying Theory to Practice, Oxford University Press, 3rd edition, ISBN-13: 978-0199772766.
5. Robert S. Devine & Robert Devine, “The Sustainable Economy” , An anchor book origin Oct 2020.

Course Outcomes

CO1: Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.

CO2: Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.

CO3: Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.

CO 4: Compute the depreciation of an asset using standard depreciation techniques to assess its impact on present worth.

MEOE434: THERMAL DESIGN AND MANAGEMENT OF ELECTRONIC EQUIPMENT

Pre-requisite: Nil

L	T	P	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course

We live in an era dominated by information, where electronic technology plays an essential role in our daily lives. The electronics industry has experienced remarkable growth in recent years, evident in the widespread presence of electronic products in various aspects of our existence. With the ever-increasing demand for faster and larger information transmission, communication, and processing, electronic devices are prone to generating more heat. In order to meet this escalating demand, it becomes crucial for us to continually explore approaches that enable early adoption of new and emerging thermal technologies, enhance quality and reliability, and reduce costs. It is now widely acknowledged that the performance and cost of an electronic system are primarily constrained not by advancements in device and chip technology alone, but by our ability to effectively package these individual chips into modules, boards, subsystems, and complete systems.

UNIT - I

Introduction– importance of thermal management of electronics, temperature effects on different failure modes; Basics of conduction, convection, radiation heat transfer.
(10 hrs)

UNIT - II

Cooling methods used in the industry for electronics–conduction cooling, cooling by heat sinks– design aspects of heat sinks, convection cooling, selection of fan, liquid immersion cooling, cold-wall cooling, cold plates, jet impingement cooling, synthetic jet cooling, thermoelectric or solid state coolers, radiative heat transfer and importance in space applications. **(10 hrs)**

UNIT - III

Cooling using phase change– cooling with PCM materials, micro/mini channel cooling, contact resistance, cooling using heat pipes– working principle, selection of heat pipe working fluid; Selection of cooling technique– ranges of cooling rates of different cooling methods, selection criteria. **(12 hrs)**

UNIT – IV

Experimental techniques used for thermal measurements; Reliability issues: importance, bathtub curve. Case studies/Latest developments/Sustainable technologies in thermal design and management of electronic equipment. **(08 hrs)**

NOTE:

The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Textbook and References:

1. Younes Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press Inc, 2010.
2. Dave S. Steinberg, Cooling Techniques for Electronic Equipment, Wiley, 1991.
3. Sung Jin Kim, Sang Woo Lee, Air Cooling Technology for Electronic Equipment, Taylor & Francis, 1996.
4. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill, 2001.
5. Yunus A. Cengel, Heat Transfer: A Practical Approach. McGraw-Hill, 2003.

Course Outcomes:

CO1: be able to appreciate the applicability of heat transfer first principles to electronics cooling.
CO2: raise awareness of the need for energy efficiency in cooling of electronic systems.
CO3: be equipped with tools to approach existing industry applications
CO4: be able to evaluate emerging thermal management techniques.

MINOR IN INDUSTRIAL MANAGEMENT

A student can register in minimum five courses (CREDITS 15) to earn minor degree.

Sr. No.	Course code	Name of the course	Core/Elective course	Pre-requisite	Credits
1	MEPC212	Industrial Engineering	Core	NIL	3
2	MEPE318	Operations Research	Core	MEPC301	3
3	MEPE407	Production Planning and Control	Elective	NIL	3
4	MEPE420	Quality Control & Assurance	Elective	NIL	3
5	MEPC319	Reliability & Maintenance Engineering	Elective	NIL	3
6	MEPE317	Logistics & Supply Chain Management	Elective	NIL	3
7	MEPE406	Engineering Economy	Elective	NIL	3
8	MEPE419	Six Sigma: Concepts and Methodology	Elective	NIL	3
9	MEPE421	Facilities Design	Elective	NIL	3
10	MEPE306	Work Study & Ergonomics	Elective	MEPC301	3
11	MEPE408	Project I	Elective	NIL	3