INSTITUTE OF ENGINEERING & TECHNOLOGY
DR. RAMMANOHAR LOHIA AVADH UNIVERSITY
AYODHYA

EVALUATION SCHEME &SYLLABUS
for
B.TECH. THIRD YEAR
(Admitted in 2020-2021)

MECHANICAL ENGINEERING DEPARTMENT

AS PER
AICTE MODEL CURRICULUM
[Effective from the Session: 2022-23]

B.Tech (Mechanical Engineering Department) Semester V

	SEMESTER V												
Sr. No	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	MEM501	Machine Design I	3	1	0	30	20	50		100		150	4
2	MET502	Theory of Machine I	3	1	0	30	20	50		100		150	4
3	MEM503	Manufacturing Technology II	3	1	0	30	20	50		100		150	4
4	MEH504	Heat & Mass Transfer	3	1	0	30	20	50		100		150	4
5	MEM505	Measurement and Metrology	3	0	0	30	20	50		100		150	3
6	MEM5L1	Machine Design I Lab	0	0	2				25		25	50	1
7	MEM5L2	Manufacturing Technology II Lab	0	0	2				25		25	50	1
8	MEH5L3	Heat & Mass Transfer Lab	0	0	2				25		25	50	1
9	MEP501/ MEI501/ MES501	Mini Project/Internship Assessment/ Seminar	0	0	2				50			50	1
10		Value Aided Course	0	0	2				50			NC+	NC+
11		**Total**	**15**	**4**	**8**							**950**	**23**

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

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

	SEMESTER VI												
Sr. No	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	MER601	Refrigeration & Air Conditioning	3	1	0	30	20	50		100		150	4
2	MET602	Theory of Machine II	3	1	0	30	20	50		100		150	4
3	MEM603	Machine Design II	3	0	0	30	20	50		100		150	3
4	MED601 to 604	Departmental Elective 1	3	0	0	30	20	50		100		150	3
5	MED605 to 608	Departmental Elective 2	3	0	0	30	20	50		100		150	3
6	MER6L1	Refrigeration & Air Conditioning Lab	0	0	2				25		25	50	1
7	MET6L2	Theory of Machine II Lab	0	0	2				25		25	50	1
8	MEM6L3	Machine Design II Lab	0	0	2				25		25	50	1
9		Value Added Courses											NC+
		Total	**15**	**2**	**6**							**900**	**20**

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

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

Departmental Electives

	Course Code	Name of Subject
Departmental Elective-1	MED601	Industrial Engineering
	MED602	Solar Thermal System and Application
	MED603	Mechanical Vibrations
	MED604	Fuel Combustion and Pollution
Departmental Elective-2	MED605	I. C Engines and Compressors
	MED606	Computer Integrated Manufacturing
	MED607	Advanced Manufacturing Technology
	MED608	Finite Element Method

Machine Design I

L-T-P
3-1-0
MEM501

Course Objectives:

- To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
- To illustrate to students the variety of mechanical components available and emphasize the need to continue learning.
- To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.

Syllabus

UNIT I

Introduction Definition, Design requirements of machine elements, Design procedure, Standards in design, Selection of preferred sizes, Indian Standards designation of carbon & alloy steels, Selection of materials for static and fatigue loads. Design for Static Load Modes of failure, Factor of safety, Principal Stresses, Stresses due to bending and torsion, Theory of failure. 8(L)

UNIT II

Design for Fluctuating Loads Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria. Riveted Joints Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint. 8(L)

UNIT III

Shafts Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity. 8(L)

UNIT IV

Mechanical Springs Types, Material for helical springs, End connections for compression and tension helical springs, Stresses and deflection of helical springs of circular wire, Design of helical springs subjected to static and fatigue loading. 8(L)

UNIT V

Power Screws Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack Keys and Couplings Types of keys, splines, Selection of square & flat keys, Strength of sunk key, Couplings, Design of rigid and flexible couplings. 8(L)

Course Outcomes:

CO-1	Understand the customers' need, formulate the problem and draw the design specifications.
CO-2	Students will be able to analyze different loading conditions such as static,

	fatigue and impact load using theories of failure. Design threaded fasteners under static, dynamic and impact loads.
CO-3	Students will be able to design shafts under fluctuating and combined loads, cotter & knuckle joint, keys and couplings
CO-4	Students will be able to design different machine components such as Riveted and Welded joints, power screws such as screw jack

Text Books:

- Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Co.
- A Text book of Machine Design by R. S. Khurmi and J. K. Gupta, Eurasia Publishing House Pvt. Ltd.
- Shigley, J.E and Mischke, C. R. Mechanical Engineering Design, 6/e, Tata McGraw Hill, 2005.
- Norton, R. L., Machine Design: An Integrated Approach, 3/e, Pearson, 2004.
- Machine Design-Sharma and Agrawal, S.K. Kataria & Sons.
- Machine Design, U C Jindal, Pearson Education.

References Books:

- Black P. H. and O. E. Adam, "Machine Design", Tata McGraw Hill Publication. Co. Ltd, New Delhi
- K. Lingaiah, "Machine Design Data book", Tata McGraw Hill Publication. Co. Ltd, New Delhi

E Portals:

- Link for the Video Lecture of NPTEL
https://www.youtube.com/watch?v=mzWMdZZaHwI&list=PL3D4EBCBFAA99D9B

Theory of Machine I

L-T-P
3-1-0
MET 502

Course Objectives

1. To determine the DOF of planner mechanism.
2. To understand inversion of mechanism.
3. To determine displacement of followers.
4. To determine the velocity ratio of positive drive.
5. To understand the principles of gearing.

Unit I

Introduction, mechanisms and machines, kinematics and kinetics, types of links, kinematic pairs and their classification, types of constraint, degrees of freedom of planar mechanism, Grubler's equation, mechanisms, inversion of four bar chain, slider crank chain and double slider crank chain.

Velocity analysis: Introduction, velocity of point in mechanism, relative velocity method, velocities in four bar mechanism, instantaneous centre.8(L)

Unit II

Acceleration analysis: Introduction, acceleration of a point on a link, acceleration diagram, Corioli's component of acceleration, crank and slotted lever mechanism. Klein's construction for slider crank mechanism and four bar mechanism, analytical method for slider crank mechanism.

Kinematic synthesis of mechanism:

Introduction, dimension synthesis of mechanisms, motion, path and function generation, Cheybyshev spacing, three position synthesis graphical approach for four link mechanism, straight line mechanism special mechanism8(L)

Unit III

Cams: Introduction, classification of cams and followers, cam profiles for knife edge, roller and flat faced followers for uniform velocity, uniform acceleration, simple harmonic and cycloidal motion of follower. Analytical methods of cam profile8(L)

Unit IV

Gears and gear trains Introduction, classification of gears, law of gearing, tooth forms and their comparisons, systems of gear teeth, length of path of contact, contact ratio, minimum number of teeth on gear and pinion to avoid interference, simple, compound, reverted and planetary gear trains, sun and planet gear train.8(L)

Unit V

Friction: Introduction Law of friction and types of lubrication,

Friction drives: Introduction, belt and rope drives, open and crossed belt drives, velocity ratio.

slip, power transmission, and effect of mass of belt on power transmission, maximum power transmission, initial tension and maximum tension. 8(L)

COURSE OUTCOME

CO 1	Understand the principles of kinematic pairs, chains and their Classification, DOF, inversions, equivalent chains and planar mechanisms.
CO2	Student will able to find out displacement of follower and they able to draw cam profile
CO3	Evaluate gear tooth geometry and select appropriate gears for the required applications.
CO4	Student will calculate the power lost due to friction in bearings and braking torque value in brakes

Text/Reference Books:

1. Kinematics and dynamics of machinery: Wilson and Sadler, Third edition, Pearson.
2. Theory of Mechanisms and Machines: Amitabh Ghosh and Ashok kumar Mallik, Third Edition Affiliated East-West Press.
3. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press
4. Kinematics and dynamics of machinery: R L Norton, McGraw Hill
5. Theory of Mchines: S.S. Rattan, McGraw Hill
6. Theory of Mchines: Thomas Bevan, CBS Publishers.

Manufacturing Technology II

L-T-P
3-1-0
MEM 503

Course Objectives:

1. To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching
2. To teach principles of metal joining (welding) process and their application
3. To understand the basic concept of non-traditional machining processes.

Unit I

Metal Cutting

Mechanics of metal cutting. Geometry of tool and nomenclature .ASA system Orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required. Heat generation and cutting tool temperature, Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Dynamometer, Brief introduction to machine tool vibration and surfacefinish. Economics of metal cutting. 10(L)

Unit-II

Machine Tools

(i) Lathe: Principle, construction, types, operations, Turret/capstan, semi/Automatic, Tool layout
(ii) Shaper, slotter, planer: Construction, operations & drives.
(iii) Milling: Construction, Milling cutters, up & down milling. Dividing head & indexing. Max chip
thickness & power required.
(iv) Drilling and boring: Drilling, boring, reaming tools. Geometry of twist drills. 8(L)

Unit-III

Grinding & Super Finishing

(i) Grinding: Grinding wheels, abrasive & bonds, cutting action. Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing. Max chip thickness and Guest criteria. Surface and cylindrical grinding. Centerless grinding
(ii) Super finishing: Honing, lapping and polishing. 6(L)

Unit-IV

Metal Joining (Welding)

Survey of welding and allied processes. Gas welding and cutting, process and equipment. Arc welding: Power sources and consumables. TIG & MIG processes and their parameters.Resistance welding - spot, seam projection etc. Other welding processes such as

atomic hydrogen, submerged arc, electroslag, friction welding Soldering & Brazing. Adhesive bonding. Thermodynamic and Metallurgical aspects in welding and weld. weld-ability,Shrinkage/residual stress in welds. Distortions & Defects in welds and remedies. Weld decay in HAZ. 10(L)

Unit-V

Introduction to Unconventional Machining and Welding

Need & benefits, application and working principle of EDM, ECM, LBM, EBM, USM. AJM, WJM. Similarly, non-conventional welding applications such as LBW, USW, EBW, Plasma- arc welding, Diffusion welding, Explosive welding/cladding. Introduction toHybrid machining processes 6(L)

Course Outcomes:

1. Upon Completion of this course, the student will be able to understand and compare the function and applications of different metal cutting tools.
2. Upon Completion of this course, the student can able to apply the different metal removing, finishing and super finishing and for component production.
3. Learn super finishing techniques.
4. Upon Completion of this course, Learner will be able to illustrate the concept and application of metal joining (welding) process
5. Learn the basic concept of non-traditional machining (NTM).

Text Books:

1. Manufacturing Technology Part I and Part II,- PN. Rao, McGraw-Hill
2. Manufacturing Science – A. Ghosh and AK. Mallik,Affiliated East-West Press
3. Manufacturing Engineering & Technology, - Kalpakjian, Pearson

References Books:

1. Fundamentals of Metal Machining and Machine Tools – Geoffrey Boothroyd, CRC Press
2. Production Technology - RK. Jain Khanna Publishers.
3. Introduction to Manufacturing Processes – John A. Schey ,McGraw-Hill
4. Production Engineering Science - PC. Pandey,Standard Publishers Distributors
5. Modern Machining Processes - PC. Pandey & HS. Shan, McGraw-Hill
6. Fundamentals of Metal Cutting & Machine Tools – BL. Juneja& GS. Sekhon, Wiley
7. Process &Materials of Manufacturing – RA. Lindburg, Pearson Eductaion
8. Advanced Machining Process - VK Jain, Allied Publishers

Web Portal:

https://nptel.ac.in/courses/112105126/
https://nptel.ac.in/downloads/112105127/

Heat & Mass Transfer

L-T-P
3-1-0
MEH 504

COURSE OBJECTIVES- To enable the students to apply the concept of conduction, convection and radiation heat transfer to practical applications.

UNIT-1

Introduction to Heat Transfer:

Thermodynamics and Heat Transfer. Modes of Heat Transfer: Conduction, convection and radiation. Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism.

Conduction :

General differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems.Initial and boundary conditions.

Steady State one-dimensional Heat conduction :

Simple and Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation; Concept of thermal resistance.Analogy between heat and electricity flow; Thermal contact resistance and over all heat transfer coefficient; Critical radius of insulation. 8(L)

UNIT-2

Fins:

Heat transfer from extended surfaces, Fins of uniform cross-sectional area; Errors of measurement of temperature in thermometer wells.

Transient Conduction:

Transient heat conduction; Lumped capacitance method; Time constant; Unsteady state heat conduction in one dimension only, Heislercharts. 8(L)

UNIT-3

Forced Convection:

Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Flow across a single cylinder and a sphere; Flow inside ducts; Thermal entrance region, Empirical heat transfer relations; Relation between fluid friction and heat transfer; Liquid metal heat transfer.

Natural Convection:
Physical mechanism of natural convection; Buoyant force: Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere, Combined free and forced convection. 8(L)

UNIT-4
Thermal Radiation:
Basic radiation concepts; Radiation properties of surfaces; Black body radiation Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; ; Gray body; Shape factor; Black-body radiation; Radiation exchange between diffuse non black bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Green house effect.8(L)

UNIT-5
Heat Exchanger:
Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers.

Condensation and Boiling:
Introduction to condensation phenomena; Heat transfer relations for laminar film condensation on vertical surfaces and on outside & inside of a horizontal tube; Effect of non-condensable gases; Dropwise condensation; Heat pipes; Boiling modes, pool boiling; Hysteresis in boiling curve; Forced convection boiling.

Introduction to Mass Transfer:
Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film. 8(L)

Course Outcomes

Course Outcomes:	After taking this course students should be able to:
CO 1	Understand the basic laws of heat transfer.
CO 2	Account the consequence of heat transfer in thermal analyses of engineering systems.
CO 3	Find numerical solutions for conduction and radiation heat transfer problems.
CO 4	Evaluate the performance of heat exchanger by using the method of logarithmic mean temperature difference.
CO 5	Calculate heat transfer coefficients for natural convection.
CO 6	Evaluate problems involving steady state heat conduction in simple geometries.

Books:

1. Fundamentals of Heat and Mass Transfer, by Incroperra& DeWitt, John WileyandSons
2. Heat and Mass TransferbyCengel, McGraw-Hill
3. Heat Transfer by J.P. Holman,McGraw-Hill
4. Heat Transfer by Ghoshdastidar, Oxford UniversityPress
5. A text book on Heat Transfer, by Sukhatme, UniversityPress.
6. Heat and Mass Transfer by R Yadav, Central PublishingHouse
7. Heat and Mass Transfer by RK Rajput, S.Chand publication

Useful link:

1. https://nptel.ac.in/courses/112101097/
2. https://nptel.ac.in/downloads/112108149/

MEASUREMENT AND METROLOGY

L-T-P
3-0-0
MEM505

COURSE OBJECTIVES:

1. To provide accuracy at minimum cost.
2. Thorough evaluation of newly developed products, and to ensure that components are within the specified dimensions.
3. To determine the process capabilities.
4. To assess the measuring instrument capabilities and ensure that they are adequate for their specific measurements.
5. To reduce the cost of inspection & rejections and rework.
6. To standardize measuring methods

UNIT I

Mechanical Measurements: Introduction to measurement and measuring instruments.General concept–Generalized measurement system and its elements-Unit sand standards-measuring instruments: sensitivity, stability, range, accuracy and precision- static and dynamic response-repeatability-systematic, Source of error, statistical analysis of error and random errors-correction, calibration. Dimensional and geometric tolerance

Sensors and Transducers: Types of sensors, types of transducers and their characteristics.

UNIT II

Time Related Measurements: Stroboscope, frequency measurement by direct comparison. Measurement of displacement

Measurement of Pressure: Gravitational, directing acting, elastic and indirect type pressure transducers. Measurement of very low pressures (high vacuum).

Strain Measurement: Types of strain gauges and their working, strain gauge circuits, temperature compensation. Strain rosettes, calibration.

UNIT III

Flow Measurement: Hot Wire Anemometry, Laser Doppler Velocimetry, Rotameter

Temperature Measurement: Thermometers, bimetallic thermocouples, thermistors and pyrometers.

Measurements of Force, Torque: Different types of load cells, elastic transducers, pneumatic & hydraulic systems. Seismic instruments

Measurements of Acceleration, and Vibration: Accelerometers vibration pickups anddecibel meters, vibrometers.

UNIT IV

Coordinate measuring machine (CMM): Need, constructional features and types.
Metrology and Inspection: Standards of linear measurement, line and end standards. Interchange ability and standardization. Linear and angular measurements devices and systems **Comparators:** Sigma, Johansson's Microkrator. **Limit gauges** classification, Taylor's Principle of Gauge Design.

UNIT-V

Limits, Fits &Tolerance and Surface roughness: Introduction to Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness. Measurement of geometric forms like straightness, flatness, roundness. Tool makers microscope, profile projector, autocollimator.

Interferometry: principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: quantitative evaluation of surface roughness and its measurement.

COURSE OUTCOMES:

1. Understand the methods of measurement and selection of measuring instruments standards of measurement
2. Identify and apply various measuring instruments
3. Explain tolerance, limits of size, fits, geometric and position tolerances and gauge design
4. Recommend the Quality Control Techniques and Statistical Tools appropriately
5. Analyze the Data collected

Books and References:

1. Experimental Methods for Engineers by Holman, MCGRAW HILL INDIA
2. Mechanical Measurements by Beckwith, Pearson
3. Principles of Measurement Systems by Bentley, Pearson
4. Metrology of Measurements by Bewoor and Kulkarni, MCGRAW HILL INDIA
5. Measurement Systems, Application Design by Doeblein, MCGRAW HILL INDIA
6. Hume KJ, "Engineering Metrology", MacDonald and Co
7. Jain, RK, "Engineering Metrology" Khanna Publishers
8. Jain, R.K., "Mechanical Measurement" Khanna Publishers
9. Gupta SC, Engineering Metrology, Dhanpat Rai Publications

Machine Design I Lab

L-T-P
0-0-2
MEM5L1

Objectives:

- To understand procedure of machine design and develop an ability to apply it
- Understand use of Design Data Hand Book and ISO standards for selection of materials, strengths, standard dimensions.
- To acquire a skill of design and drafting the Bolted joint, Coupling
- To acquire a skill of design and drafting of standard welded and riveted joint as per ISO

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

1. Design of machine components subjected to combined steady and variable loads
2. Design of eccentrically loaded riveted joint
3. Design of boiler riveted joint
4. Design of shaft for combined constant twisting and bending loads
5. Design of shaft subjected to fluctuating loads
6. Design and drawing of flanged type rigid coupling
7. Design and drawing of flexible coupling
8. Design and drawing of helical spring
9. Design and drawing of screw jack

Course Outcomes:

- Apply the design knowledge and formulation for safe design.
- Able to apply design and drafting knowledge of assembly and details of Bolted joint, Coupling
- Able to apply skill of design for standard welded and riveted joint as per ISO standard
- Able to develop logical and analytical ability to check different stresses in power screw assembly

Manufacturing Technology II Lab

L-T-P
0-0-2
MEM 5L2

Objectives:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by machining, grinding, welding and unconventional machining processes.

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

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
2. Bolt (thread) making on Lathe machine
3. Tool grinding (to provide tool angles) on tool-grinder machine.
4. Gear cutting on Milling machine.
5. Machining a block on shaper machine.
6. Finishing of a surface on surface-grinding machine.
7. Drilling holes on drilling machine and study of twist-drill.
8. Study of different types of tools and its angles & materials.
9. Experiment on tool wear and tool life.
10. Experiment on jigs/Fixtures and its uses
11. Gas welding experiment
12. Arc welding experiment
13. Resistance welding experiment.
14. Soldering & Brazing experiment
15*.To study various thermal models for EDM
16*. To study influence of process parameters on the Wire EDM
17*.Study of Electrochemical machining process
18*.Laser hardening using NdYAG laser system
19*.Laser spot welding using NdYAG laser system

Upon completion of this course, students will be able to understand the different machining, grinding, welding and unconventional machining processes employed for making different products.

Heat & Mass Transfer Lab

L-T-P
0-0-2
MEH 513

1. Conduction - Experiment on Composite plane wall
2. Convection - Heat transfer through fin-(natural convection)
3. Convection - Experiment on heat transfer from tube/fin-(forced convection).
4. Experiment on Stefan's Law on radiation determination of emissivity, etc.
5. Heat exchanger: parallel flow/counter flow experiment

Course Outcomes

After taking this course students should be able to:

1. Analyze conduction by performing composite wall experiment
2. Analyze convection by performing heat transfer through fin-natural convection
3. Analyze convection by performing heat transfer through tube/fin-forced convection
4. Analyze radiation by performing experiment on Stefan's law.
5. Analyze heat exchanger by performing - Parallel flow / Counter flow experiment

Refrigeration & Air Conditioning

Course Objectives

L-T_P
3-0-0
MER601

1. To provide fundamentals of refrigeration and air conditioning. Psychrometry.
2. To accustom with various methods of production ofcold.
3. To impart knowledge about applications of refrigeration and air conditioning

Unit-I

Refrigeration: Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P.

Air Refrigeration cycle: Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART). **8(L)**

Unit-II

Vapour Compression System: Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system. **8(L)**

Unit-III

Vapour Absorption system: Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium-Bromide water vapour absorption system, Comparison.

Refrigerants: Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants. Ozone layer depletion and global warming considerations of refrigerants. **8(L)**

Unit-IV

Air Conditioning: Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Air Washers, Cooling towers & humidifying efficiency. **8(L)**

Unit-V

Refrigeration Equipment & Application: Elementary knowledge of refrigeration & air conditioning equipment se.g.S compressors, condensers, evaporators & expansion devices, Food preservation. Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning. **8(L)**

Course Outcome

CO1	Understand the principles and applications of refrigeration systems.
CO2	Understand vapour compression refrigeration system and identify methods for performance improvement.
CO3	Study the working principles of air, vapour absorption, thermoelectric andsteam-jet refrigeration systems.
CO4	Analyze air-conditioning processes using the principles of psychrometry.
CO5	Evaluate cooling and heating loads in an air-conditioning system.

Text/Reference Books:

1. Refrigeration and Air conditioning by C.P Arora, McGraw-Hill
2. Refrigeration and Air conditioning, by Manohar Prasad, New Age International (P) Ltd.Pub.
3. Refrigeration and Air conditioning by R. C. Arora, PHI
4. Principles of Refrigeration by Roy J. Dossat. Pearson Education
5. Refrigeration and Air conditioning by stoecker& Jones. McGraw-Hill
6. Refrigeration and Air conditioning by Arora&Domkundwar. DhanpatRai
7. Thermal Environment Engg. byKuhen, Ramsey &Thelked

Theory of Machine 2

L-T-P
3-1-0

MET602

Course Objectives:

1. To determine the balancing of masses of rotating and reciprocating machine elements
2. To understand the principles of gyroscope and governors
3. To determine the forces and power calculations for brakes and dynamometer
4. To determine the static and dynamic forces for mechanical systems
5. To understand the principles of vibrations

Unit I

Force analysis:

Static force analysis of mechanisms, D'Alembert's Principle, dynamics of rigid link in plane motion, dynamic force analysis of planar mechanisms, piston force and crank effort. Turning moment on crankshaft due to force on piston, Turning moment diagrams for single cylinder double acting steam engine, four stroke IC engine and multi-cylinder engines, Fluctuation of speed, Flywheel. 8(L)

Unit II

Balancing:

Introduction, static balance, dynamic balance, balancing of rotating masses, two plane Balancing, graphical and analytical methods, balancing of reciprocating masses, 8(L)

Unit III

Gyroscope: Gyroscopes, Gyroscopic forces and couples, Gyroscopic stabilization, Gyroscopic effects on naval ships, Steering, pitching and rolling, Ship stabilization, Stability of four wheel and two wheel vehicles moving on curved paths, Gyroscopic effects on an aeroplane.

Mechanical Vibration:

General terms and classification of vibrations, Harmonic motion, Periodic functions, Harmonic analysis, Equation of motion, Free and forced vibration, Damping, Resonance, Energy method, Rayleigh's method, Unbalance, whirling speed of shaft, Transient vibration. 8(L)

Unit IV

Governors:

Introduction, types of governors, characteristics of centrifugal governors, gravity controlled
And spring controlled centrifugal governors, hunting of centrifugal governors, inertia Governors. Effort and Power of governor. 8(L)

Unit V

Brakes and Clutches:

Introduction, Law of friction and types of lubrication, types of brakes, effect of braking on rear and front wheels of a four wheeler.
Clutches, Single plate clutch, Multiple plate clutch, Cone clutch 8(L)

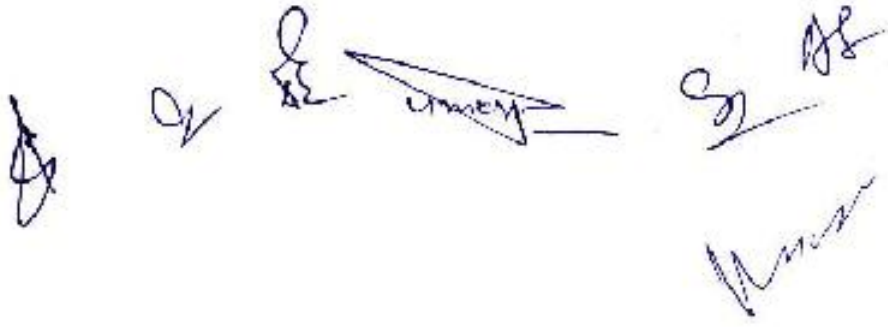
Course Outcome:

CO Number	Course Outcome (Please include all COs of your Course here)
CO1	Define the basic parametric analysis related to connecting rod in slider crank mechanism in static and dynamic conditions with draw corresponding turning moment diagram.

CO2	**Describe** and **explain** general governing conditions for dynamic bodies, brakes, clutches and damping effect.
CO3	**Calculate** and **analyze** parameters analysis of motion of vibrating bodies, height of governor, effect of braking etc.
CO4	**Design** and **compare** various types of governor, clutches and brakes.
CO5	**Evaluate** and analysis for vibrating bodies, balancing of masses & gyroscopic effects for rotating bodies.

Text/Reference Books:

1. Kinematics and dynamics of machinery: Wilson and Sadler, Third edition, Pearson.
2. Theory of Mechanisms and Machines: Amitabh Ghosh and Ashok kumar Mallik, Third Edition Affiliated East-West Press.
3. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press
4. Kinematics and dynamics of machinery: R L Norton, McGraw Hill
5. Theory of Machines: S.S. Rattan, McGraw Hill



L-T-P
3-0-0
MEM 603

Machine Design II

L-T-P
3-0-0
MEM603

Course Outcomes

1. To understand the standard nomenclature, forces, failures, application, design procedure of Spur and Helical gears (As per AGMA) and to determine standard geometry under given loading condition by using design data hand book and AGMA procedure.
2. To understand the standard nomenclature, forces, failures, application, design procedure of Bevel and Worm gears (As per AGMA) and to determine standard geometry under given loading condition by using design data hand book and AGMA procedure.
3. To understand the different types of bearings, application, failures, design procedure of Ball Bearings and Sliding contact bearing and to determine standard design procedure of bearing under different loading condition by using design data hand book.

UNIT I

Spur Gears

Principle of transmission and conjugate action, Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards. 4

4

Helical Gears

Terminology, Proportions for helical gears, Forces components on a tooth of helical gear, Virtual number of teeth, Beam strength& wear strength of helical gears, Dynamic load on helical gears, Design of helical gears.

UNIT II

Bevel gears 4

Terminology of bevel gears, Force analysis, Virtual number of teeth, Beam strength and wear strength of bevel gears, Effective load of gear tooth, Design of a bevel gear system.

UNIT III

Worm Gears 4

Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing system.

Unit-IV

Sliding Contact Bearing

Types. Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing 4

UNIT IV

IC ENGINE Parts 8

Selection of type of IC engine, General design considerations, Design of cylinder and cylinder head; Design of piston and its parts like piston ring and gudgeon pin etc. Design of connecting rod; Design of crankshaft

Course Outcomes:

1. Able to understand the standard geometry, application, failures of Spur andHelical Gear and Design and Developed effectively Spur and Helical Gears fordifferent loading conditions
2. Able to understand the standard geometry, application, failures of Bevel andWorm Gear and Design and Developed effectively Bevel and Worm Gear fordifferent loading conditions.
3. The students will be familiar to analyze & design of Sliding Contact Bearingand Rolling contact bearing.
4. The students will be familiar to analyze & design various engine parts likepiston, connecting rod and valve gear mechanism and to understandintroductory concepts of design for manufacturing & assembly.

Text Books:

- Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Co.
- A Text book of Machine Design by R. S. Khurmi and J. K. Gupta, Eurasia Publishing House Pvt. Ltd.
- Shigley, J.E and Mischke, C. R. Mechanical Engineering Design, 6/e, Tata McGraw Hill, 2005.
- Norton, R. L., Machine Design: An Integrated Approach, 3/e, Pearson, 2004.
- Machine Design-Sharma and Agrawal, S.K. Kataria& Sons.
- Machine Design, U C Jindal, Pearson Education.

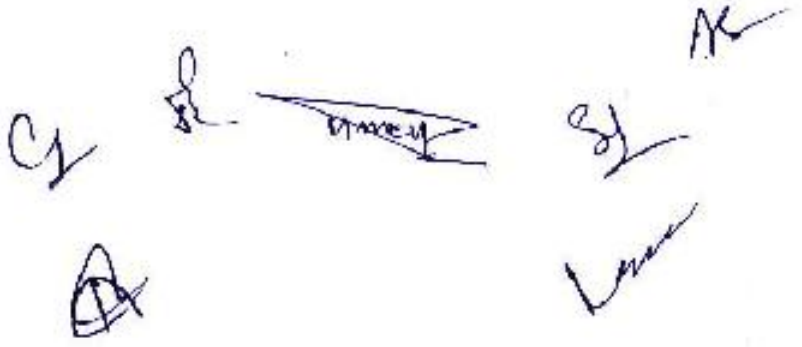
References Books:

- Black P. H. and O. E. Adam, "Machine Design", Tata McGraw Hill Publication. Co Ltd. New Delhi
- K. Lingaiah. "Machine Design Data book", Tata McGraw Hill Publication. Co. Ltd, New Delhi

E Portals:

Link for the Video Lecture of NPTEL

https://www.youtube.com/watch?v=mzWMdZZaHwI&list=PL3D4EECEFAA99D9BE



Departmental Elective 1

Industrial Engineering

L-T-P
3-0-0
MED601

Course Objective:
To enable the students understand establishing methods for improving operations and controlling production costs.

Unit-I:
Overview of Industrial Engineering: Types of production systems, concept of productivity, productivity measurement in manufacturing and service organizations, operations strategies, liability and process design.

Facility location and layout: Factors affecting facility location; principle of plant layout design, types of plant layout; computer aided layout design techniques; assembly line balancing; materials handling principles, types of material handling systems, methods of process planning, steps in process selection, production equipment and tooling selection, group technology, and flexible manufacturing. **8(L)**

Unit II:
Production Planning and control: Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; materials requirement planning (MRP) and MRP-II; routing, scheduling and priority dispatching, concept of JIT manufacturing system
Project Management: Project network analysis, CPM, PERT and Project crashing. **8(L)**

Unit III:
Engineering economy and Inventory control: Methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements, time-cost trade-off, resource levelling; Inventory functions, costs, classifications, deterministic inventory models, perpetual and periodic inventory control systems, ABC analysis, and VED analysis.
Queuing Theory: Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Classification of Queuing models. **8(L)**

Unit IV
Work System Design: Taylor's scientific management, Gilbreths's contributions; work study: method study, micro-motion study, principles of motion economy; work measurement –time study, work sampling, standard data, Predetermined motion time system (PMTS); ergonomics; job evaluation, merit rating, incentive schemes, and wage administration.

Product Design and Development: Principles of product design, tolerance design: quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, and concurrent engineering. **8(L)**

Unit V:

Operational Analysis: Formulation of LPP, Graphical solution of LPP, Simplex Method, Sensitivity Analysis, degeneracy and unbound solutions. Transportation and assignment models; Optimality test: the stepping stone method and MODI method, simulation. **8(L)**

Course Outcomes:

The students will be able to-

CO1: Understand the concept of production system, productivity, facility and process planning in various industries.

CO2: Apply the various forecasting and project management techniques

CO3: Apply the concept of break-even analysis, inventory control and resource utilization using queuing theory.

CO4: Apply principles of work study and ergonomics for design of work systems

CO5: Formulate mathematical models for optimal solution of industrial problems using linear programming approach.

Books and References:

1. Industrial Engineering and Production Management by Martand T Telsang S. Chand Publishing
2. Industrial Engineering and Production Management by M. MahajanDhanpatRai& Co. (P) Limited
3. Industrial Engineering and Management by Ravi Shankar, Galgotia Publications Pvt Ltd
4. Production and Operations Management by Adam, B.E. & Ebert, R.J., PHI
5. Product Design and Manufacturing by Chitale A.V. and Gupta R.C., PHI
6. Operations Research Theory & Applications by J K Sharma, Macmillan India Ltd,
7. Production Systems Analysis and Control by J.L.Riggs, John Wiley & Sons
8. Automation, Production Systems & Computer Integrated Manufacturing by Groover, M.P. PHI
9. Operations Research, by A.M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education
10. Operations Research by P. K. Gupta and D. S. Hira, S. Chand & Co

Solar Thermal System and Application

L-T-P
3-0-0
MED 602

Course objective

To enable the students understand the fundamentals of solar energy and its direct and indirect applications:

UNIT I:

The energy crisis: causes and options, renewable and non-renewable forms of energy and their characteristics, solar energy option – availability and landarea requirements. **4(L)**

UNIT 2:

Solar radiation outside the earth's atmosphere and at the earth's surface, instruments for measuring solar radiation, solar radiation geometry, basic earth-sun angles, flux on tilted surfaces. **8(L)**

UNIT 3:

Liquid flat-plate collectors-design and performance parameters, solar air heaters, concentrating collectors, solar ponds and energy storage. **8(L)**

UNIT 4:

Solar thermal power generation-low, medium and high temperature cycles, solar cooling, drying and desalination, solar air and water heating, solar passive architecture. **8(L)**

UNIT 5:

Solar photovoltaic power generation-monocrystalline, polycrystalline and amorphous cells, Fabrication and performance of SPV modules. **8(L)**

UNIT 6:

Indirect methods of solar energy utilization-biomass, wind, wave and ocean thermal energy conversion technologies. Economic considerations. **6(L)**

Course outcomes

After learning the course the students should be able:

CO1	To understand the basic concept of solar energy and performance of various type of solar collector.
CO2	To make suitable selection of solar collector for a given application.
CO3	Predict the performance of solar photovoltaic device and analyze its performance

CO4	To develop skills in critical thinking and reasoning about issues associated with direct and indirect use of solar energy.

Text/Reference Books:

1. 'Solar Energy–Fundaments, Design, Modeling & Applications' by G.N. Tiwari 2002, Narosa Publishing House, New Delhi, India.
2. 'Solar Energy Engineering' by S. Kalogirou, Academic Press.
3. 'Heat & Mass transfer' by Y.A. Cengel, Mcgraw Hill.
4. 'Solar Engineering of Thermal Processes' by J.A. Duffie and W.A. Beckman 1991. John Wiley and Sons Inc., New York.
5. 'Solar Energy- Principles of Thermal Collection and Storage' – by Sukhatme, Tata Mcgraw Hill.
6. 'Solar Energy- Fundamentals and Applications' by Garg and Prakash, Tata Mcgraw Hill.
7. 'Advanced Renewable Energy Sources' by G.N. Tiwari and R.K. Mishra 2012, RSC Publishing, Cambridge, U.K.
8. 'Solar Photovoltaics: Fundamentals, Technologies and Applications' by Chetan Singh Solanki 2012, PHI Learning Pvt. Ltd., New Delhi.

Mechanical Vibrations

L-T-P
3-0-0
MED 603

COURSE OBJECTIVES:

1. To study basic concepts of vibration analysis and observe, analyze, understand the concept of vibrations in mechanical systems , various technique to solve single degree freedom and single dof without damping with damping, 2-degree, forced vibration and, Estimate natural frequency of mechanical system multi degree freedom system using various numerical techniques.
2. To acquaint with the principles of vibration measuring instruments
3. To recognize how to apply theory of vibration to engineering problems.
4. To study balancing of mechanical systems, and able to mathematically formulate real-world vibration problems in engineering.

UNIT - I

Introduction

Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, Fourier analysis **3(L)**

Single Degree Freedom System

Free vibration, Natural frequency, Equivalent systems, Energy method for determining natural frequency, response to an initial disturbance, Torsional vibrations, Damped vibrations, Vibrations of systems with viscousdamping, Logarithmic decrement **5(L)**

UNIT - II

Single Degree Freedom: Forced Vibration

Forced vibration, Harmonic excitation with viscous damping, steady state vibrations, Excitation due to rotating and reciprocating unbalance, Support excitation, Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments **8(L)**

UNIT- III

Two Degree Freedom systems

Introduction, Principal modes, Double pendulum, Torsional system with damping, coupled system, undamped dynamic vibration absorbers, Centrifugal pendulum absorbers, Dry friction damper **8(L)**

UNIT- IV

Multi Degree Freedom system: Exact Analysis

Undamped free and forced vibrations of multi-degree freedom systems, influence Co-efficients, Reciprocal theorem, Generalized co-ordinates and co-ordinate couples, Natural frequencies and mode shapes modal analysis ofundamped systems. **8(L)**

UNIT- V

Multi Degree Freedom system: Numerical Analysis

Rayleigh"s, Dunkerely"s, Holzer"s ad Stodola methods, Rayleigh-Ritz method **5(L)**

Critical speed of Shafts

Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed. **3(L)**

COURSE OUTCOMES: Learner will be able to

CO1: Define basic concepts of vibration of bodies having one, two and multi degree freedom Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF systems.

CO2: Discuss equations of motion Analyze vibratory response of mechanical element/system for Free undamped and damped and forced vibration response and estimate the parameters of vibration isolation systems for industrial environment.

CO3: Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques

CO4: Explore modern vibration measuring instruments. Condition monitoring of working machineries.

Books and References:

1. Mechanical Vibrations – P. Srinivasan, TMH
2. Mechanical Vibrations – G. K. Groover, Jain Brothers, Roorkee
3. Mechanical Vibrations – W. T. Thomson
4. Mechanical Vibrations – JS Rao & K Gupta, New Age
5. Mechanical Vibrations – Tse, Morse & Hinkle
6. Mechanical Vibrations – V. Rama Murthy, Narosa Publications

Fuel Combustion and Pollution

L-T-P
3-0-0
MED 604

Course Objective: To learn about types of fuels and their characteristics, combustion systems and pollution due to emission with emphasis on engineering applications.

UNIT I:

Chemistry of Combustion-Combustion and its Chemistry, Heat, Types of Fuel, Molecularity and order of reaction, Rates of reaction, Arrhenius equation. Conservation equations of mass, momentum, energy and species for a multicomponent system. **8(L)**

UNIT II:

Combustion of gaseous fuel jets- Premixed and diffusion flames, Laminar and turbulent flames. Concepts of kinetically controlled and diffusion controlled reactions, Flammability limits, Ignition, Burning velocity, Flame structure and Stability for laminar flames. **10(L)**

UNIT III:

Liquid Fuel combustion-Atomization of liquid, Various atomizers and their performances Evaporation of droplets in high temperature gas streams, Simple model of droplet burning, Physical and mathematical models of spray flames. **8(L)**

UNIT 4:

Combustion of Solids-Description of carbon sphere combustion, Diffusional theory of carbon combustion of pulverized coal. **7(L)**

UNIT 5:

Pollution- Pollutant formation in various combustion processes and their controlling measures. **7(L)**

Course Outcome:

CO1	Ability to characterize the fuels
CO2	Understanding of thermodynamics and kinetics of combustion
CO3	Understand and analyze the combustion mechanisms of various fuels
CO4	Understand and analyze the chemistry of pollution due to fuel emission
CO5	Ability to justify the use of pollution control equipment and their design

Text/Reference Books:

1 An Introduction to Combustion: Concepts and Applications by Stephen R. Turns

2 Combustion Engineering by G. L. Borman, K. W. Ragland

Departmental Elective-2

I.C Engines andCompressors

L-T-P
3-0-0
MED 605

Course Objective

To understand the implications of Mechanical Engineering about the engine terminology, operation of internal combustion engines within the scope of the curriculum disclosure of issues such as history, basic concepts, Mixture Characteristics, combustion, the actual cycle, knock, power calculations and the gas exchange.

Unit-I

Introduction to I.C Engines: Engine classification and basic terminology, Two and four stroke engines. SI and CI engines, Valve timing diagram.Thermodynamic analysis of Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Stirling cycle, Ericsson cycles, Comparison of Otto, Diesel and Dual cyclesFuel air cycle, factors affecting the fuel air cycle, Actual cycle. **8(L)**

Unit–II

SI Engines: Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines.Carburetion, Mixture requirements, Carburetors and fuel injection system in SI EngineIgnition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition, Scavenging in 2 Stroke engines, Supercharging and its effect. **8(L)**

Unit–III

CI Engine Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines.Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timingsExhaust emissions from SI engine and CI engine and it's control. **8(L)**

Unit-IV

Engine Cooling and Lubrication: Different cooling systems, Radiators and cooling fans, Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation.Fuels: Fuels for SI and CI engine , Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines.Testing and Performance: Performance parameters, Basic measurements, Blow by measurement, Testing of SI and CI engines. **8(L)**

Unit V

Compressors: Classification, Reciprocating compressors, Single and Multi stage compressors, Intercooling, Volumetric efficiency. Rotary compressors, Classification, Centrifugal compressor, Axial compressors, Surging and stalling, Roots blower, Vaned compressor. **8(L)**

Course Out Comes:

1. Explain basic concepts of actual cycles with analysis and to describe the fundamental concepts of IC engines along with its working principles.
2. Describe the combustion phenomenon in SI and CI engines.
3. Evaluate the performance of IC engines and the importance of alternate fuels.
4. Illustrate the working principle of different types of compressors.

Reference Books-

1. "Internal Combustion Engines" by Ganesan V
2. "Internal Combustion Engine Fundamentals" by John Heywood
3. "Internal Combustion Engines" by Mathur M L & Sharma R P
4. "Fundamentals of Internal Combustion Engines" by Gupta HN
5. "A Textbook of Internal Combustion Engines" by R K Rajput

E PORTALS-

https://nptel.ac.in/courses/112104033/

https://nptel.ac.in/courses/112103262/

Computer Integrated Manufacturing

L-T-P
3-0-0
MED 606

Course Objective:

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

UNIT I:

Introduction to Computer Integrated Manufacturing and Manufacturing Enterprise- Fundamentals of Automation in Manufacturing Systems, Manufacturing Systems: concept Objectives, Types and Trends; concepts of Mechanization, Automation and Integration, Manufacturing enterprise, Manufacturing Systems Manufacturing Cells, Group technology and cellular Manufacturing, Flexible Manufacturing Systems Automated Manufacturing Systems, Concept of CAD/CAM and CIMS. **8(L)**

UNIT II:

The design elements and production engineering-product design & production engineering, Design Automation and computer aided Engineering (CAE) **6(L)**

UNIT III:

Managing the enterprise resources-Introduction to production operation planning, Planning and Scheduling Functions in CIM System, Aggregate Production Planning (APP), Master Production Schedule (MPS), Material Requirement Planning (MRP), Capacity Requirement Panning (CRP), Manufacturing Resource Planning (MRP-II), Just – In –time Production Systems and Concept of Enterprise Resource Planning (ERP). **10(L)**

UNIT IV:

Enabling processes and systems for modern-Manufacturing Production Process machines and system Production Machine and systems control Quality and Human Resource issues in manufacturing **6(L)**

UNIT V:

Introduction to Advanced Manufacturing System-Lean Manufacturing Systems, Agile Manufacturing systems, Reconfigurable Manufacturing systems, Holonic Manufacturing Systems and Agent-Based Manufacturing Systems, Automated Material Handling Systems-Industrial Robots Conveyors AGVs, Automatic Storage and Retrieval Systems. **10(L)**

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

CO1 - Describe various types of automation and production concepts.
CO2 - Distinguish various automated flow lines in high volume production systems.
CO3 - Analyze and Design appropriate automated assembly systems
CO4 - Apply Computer aided process planning, and learn about Automated Material Handling Systems

Text/Reference Books:

1. James A. Rehg and Henry W. Kraebber, 2005. Computer-Integrated Manufacturing. Second Edition, Pearson (Singapore) Private Ltd., Delhi.
2. Mikell P. Groover, 2005, Automation Production Systems and Computer-Integrated Manufacturing. Second Edition, Pearson (Singapore) Private Ltd., Delhi.
3. A Allavudeen and N. Venketeswaran, 2008 computer Integrated manufacturing , Prentice- Hall India Pvt Ltd. New Delhi.
4. Andrew Kusiak, 1990. Intelligent Manufacturing Systems, Englewood Cliffs, New Jersey: Prentice Hall.
5. N. Viswanadham and Y Narahari 1998 Performance Modeling of Automated Manufacturing System. Prentice- Hall India Pvt Ltd. New Delhi

Advanced Manufacturing Technology

L-T-P
3-0-0
MED 607

Course Objectives

The objective of the course is to provide the students the knowledge of modern manufacturing processes such as Ultrasonic machining, Abrasive machining processes, Electrochemical machining, Electro discharge machining & their modifications into hybrid processes. Also to introduce them to advanced topics such as Laser beam welding/machining, Electron beam welding/machining & state of art in various research areas.

UNIT 1:

Introduction- Need and classification of unconventional manufacturing processes, brief overview. **1(L)**

UNIT 2:

Unconventional Machining Processes-Process Principle, Analysis and Applications of Electric Discharge Machining, Laser Beam Machining, Electron Beam Machining, Ion Beam Machining, Plasma Beam Machining, Ultra-Sonic Machining, Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ice Jet Machining, Electrochemical Machining, Chemical Machining, Bio Chemical Machining. Hybrid Machining Processes: Electrochemical Discharge Machining, Electro-Chemical Abrasive Grinding, Electro Discharge Abrasive Grinding. **15(L)**

UNIT 3:

Unconventional Finishing Processes-Need, classification, process principle and applications of Abrasive Flow Finishing, Magnetic Abrasive Flow Finishing, Magnetic Abrasive Finishing, Electrogel Magnetic Abrasive Finishing, Magneto-Rheological Finishing. **6(L)**

UNIT 4:

Unconventional Welding Processes- Laser Beam Welding, Electron Beam Welding, Ultra-Sonic Welding, Plasma Arc Welding, Explosive Welding, Under Water Welding, Welding in Space, Micro Welding Processes. **6(L)**

UNIT 5:

Generative Manufacturing Processes-Concept of generative manufacturing, need and Classification, Process principle and Applications of Selective Laser Sintering, Fused Deposition Manufacturing, Stereo Lithography, Ballistic Particle Manufacturing, Three Dimensional Printing, Laminated Object Manufacturing. **9(L)**

UNIT 6:

Unconventional Forming Processes- Explosive forming, Electro hydraulic forming, Electro-magnetic forming, Laser Bending, Powder rolling, Spray rolling, Hydro forming, Hydrostatic and Powder extrusion, powder, rotary and isothermal forming. **6(L)**

Course Outcomes

1. Students will be able to categorize different material removal, joining processes as per the requirements of material being used to manufacture end product.
2. Students will be able to select material processing technique with the aim of cost reduction, reducing material wastage & machining time.
3. Students will be able to identify the process parameters affecting the product quality in various advanced machining of metals/ non-metals, ceramics and composites.
4. Students will be able to combine & develop novel hybrid techniques from the state of art techniques available.
5. Students will be able to perform process analysis taking into account the various responses considered in a process.

Text/Reference Books:

1- Non Traditional Manufacturing Processes by G.F. Benedict, Marcel Dekker Inc, New York
2- Advanced Machining Processes by V.K. Jain, Allied Publisher Bombay
3- Advanced Machining Methods by J.A.McGough, Chapman and Hall, London

4- New technology by Bhattacharaya
5- Modern Machining Process by Aditya
6- Manufacturing Science by Ghosh and Malik, EWP Private Ltd.
7- Modern Machining Processes by Pandey and Shan, TMH Publication, New Delhi
8- Solid Freedom Manufacturing by D. Kochan
9- Advanced Machining Processes by Hassan Abdel-Gawad El-Hofy

Finite Element Method

L-T-P
3-0-0
MED 608

Course Objectives:

1. To impart structures analysis for stress, strain & dynamic loading knowledge
2. To enable formulation of the design problems into FEA.
3. To comprehend the basic concepts and enhance capabilities for solving complex problems.
4. To introduce the concepts of elastic and static analysis problems.

UNIT-I

Introduction

Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Different approaches in Finite Element Method, Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus - Euler Lagrange equation, Rayliegh Ritz method, Weighted Residual methods, Point Collocation method, Galarkin method - Steps involved in FEM. **8(L)**

UNIT-II

Types of Elements Used

Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two-dimensional elements, triangular and rectangular elements- Local and Natural Co-ordinate systems. **8(L)**

UNIT-III

Finite Element Formulation of Field Problems

1-D and 2-D heat transfer, fluid flow (incompressible and non viscous fluid) in ducts, Simple electrical and magnetic field problems. Simple Numerical examples. **8(L)**

UNIT-IV

Finite Element Formulation of Solid Mechanics Problems

1-D problem of shaft; Truss element analysis of pinned truss. Plane stress/strain problems, Axi symmetric problems, thin plate problems; Vibration of shafts & beams. 8(L)

UNIT-V

Numerical Methods in FEM

Evaluation of shape functions - One dimensional & triangular elements, Quadrilateral elements, Isoperimetric elements - Numerical Integration, Gauss Legendre quadrature -Solution of finite element equations – Gauss Elimination Method, Cholesky decomposition. 8(L)

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

1. To teach the students about the concepts of FEM and FEA.
2. Develop the knowledge to analyze structures under static and dynamic conditions.
3. Identify the numerical techniques for solving engineering problems using FEM.
4. Identify types of elements such as higher order, beams, and trusses for different applications.

Text/Reference Books:

1. Kenneth H. Huebner, Donald L. Dewhirst, Doughlas E. Smith, The *Finite Element Method* for Engineers, Wiley, fourth edition.
2. J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw-Hill Education, third edition.
3. Singiresu S Rao, Finite Element Method in Engineering, Elsevier India, fourth edition.
4. Klaus-Jrgen Bathe, Finite Element Procedures, PHI Learning, 1st Edition.
5. David S. Malkus, Michael E. Plesha, Robert D. Cook, Robert J. Witt, Concepts and Applications of Finite Element Analysis, Wiley, 4th Edition.
6. Ashok D. Belegundu, Tirupathi R. Chandrupatla, Introduction to Finite Elements in Engineering, PHI Learning, 3rd Edition.
7. K. Morgan, O. C. Zienkiewicz, Finite Elements and Approximation, Dover publication, 1st Edition.

Refrigeration and Air conditioning Lab

L-T-P
0-0-2
MER 61.1

Course Objective:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Study of various refrigeration cycles and evaluate performance using Mollier charts and/ or refrigerant property tables.
3. Comparative study of different refrigerants with respect to properties, applications and environmental issues.
4. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems

Minimum eight experiments out of the following:

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. Study of different types of expansion devices used in refrigeration system.
3. Study of different types of evaporators used in refrigeration systems.
4. To study basic components of air-conditioning system.
5. Experiment on air-conditioning test rig & calculation of various performance parameters.
6. Experiment on air washers
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compressor.
9. Visit of a central air conditioning plant and its detailed study.
10. Visit of cold-storage and its detailed study.
11. Experiment on Ice-plant.
12. Experiment on two stage Reciprocating compressor for determination of volumetric efficiency, PV diagram and effect of intercooling.
13. Study of Hermetically sealed compressor.
14. Experiment on Desert coolers.

Course Outcomes:

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

1. Conduct test on Refrigeration and air conditioning test units to study their performance.
2. Draw performance curves of these machines/systems.
3. Analyse the results obtained from the tests.
4. Draw conclusions based on the results of the experiments

Institute of Engineering & Technology

Dr. Rammanohar Lohia Avadh University

Ayodhya

Syllabus

For

M.Tech.

Mechanical Engineering(Part Time)

(Effective from the Session: 2020-21)

M. Tech. – Mechanical Engineering

SEMESTER-II

S.N.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total
						Sessional			ESE	
		Theory	L	T	Lab (*)	CT	TA	Total	Total	
1.	MTPME 211	Computer Integrated Manufacturing (CIM)	3	1		20	30*		100	150
2.	MTPME 212	Advanced Welding Technology	3	1		20	30*		100	150
3.	MTPME 213	Modern Manufacturing process	3	1		20	30*		100	150
		Total	**9**	**4**		60	90	**150**	**300**	**450**

Institute of Engineering & Technology
Dr. Rammanohar LohiaAvadh University, Faizabad

M. Tech. – Mechanical Engineering

SEMESTER-III

S.N.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total
						Sessional			ESE	
		Theory	L	T	Lab (*)	CT	TA	Total	Total	
1.	MTPME 411	Gas Turbines & Compressors	3	1		20	30*	50	100	150
2.	MTPME 412	Energy Management	3	1		20	30*	50	100	150
		Total	**6**	**2**		40	60	**100**	**200**	**300**

Institute of Engineering & Technology
Dr. Rammanohar LohiaAvadh University, Faizabad

M. Tech. – Mechanical Engineering

SEMESTER-V

S.N.	Course Code	Subject	Periods	Evaluation Scheme	Subject Total

		Theory	L	T	Lab (*)	CT	TA	Total	Total	
1.	MTPME611	Dissertation	-	-		-	-	100	200	300
		Total						**100**	**200**	**300**

(*) The existence and duration of lab will be decided as per the nature of the dissertation

Syllabus

MTPME 111 SIMULATION, MODELLING & ANALYSIS

Introduction: Simulation: a tool, advantages and disadvantages of simulation, areas of application,systems and system environment, components of a system, discrete and continuous systems, discrete event system simulation.

General Principles: Concepts in discrete event simulation, time advance algorithm, manual simulationusing event scheduling, basis properties and operations.

Models In Simulation: Terminology and concepts, statistical models: queuing systems; inventorysystems; reliability and maintainability, limited data, discrete distributions: Bernoulli distribution; Bionomial distribution; Geometric distribution, continuous distribution: Uniform

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

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

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

Books:

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

RENEWABLE ENERGY SYSTEM

MTPME 113

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

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

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

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

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

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

3. CNC Programming Handbook Smid Peter Industrial Press Inc.
4. Automation, Production systems and Computer M.P. Groover Prentice Hall of India Integrated Manufacturing
5. Computer Integrated ManufacturingPaul Ranky Prentice Hall of India

ADVANCED WELDING TECHNOLOGY

MTPME 212

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

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

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

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

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

Books:

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

Advanced Engineering Materials

MTME 044

Course Learning Objective:

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

Ferrous Materials:

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

Non Ferrous Materials, Super Alloys, Bio-Materials:

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

Polymeric Materials:

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

Composite Material, Semi and Super Conducting Materials:

Hard magnetic materials, properties and applications, Composite materials : classification,MMC's preparation of composite materials, properties and applications, FRP contains composites preparation of composite materials, properties and applications, particulate RP composite, preparation of composite materials, properties and applications, semi conducting

ENERGY MANAGEMENT

Introduction: Energy sources, Energy demand and supply, Energy crisis, Future scenario, Menace of power theft. reasons for power pilferage, electricity loss and theft-National and Global scenario, Security seals and tampering, harmonics and power theft, Control Over power theft.

Energy system efficiency, Energy conservation aspects, Instrumentation and measurements. Principles of Energy Management and Energy Audit: General principles, Planning and program, Introduction to energy audit, General methodology, Site surveys, Energy systems survey, Energy audit, Instrumentation, Analysis of data and results.

Text Books:

1. Amlan Chakrabarti, "Energy Engineering and Management ", PHI Learning Private Limited
2. W R Murphy, G Mckay, 'Energy Management' B.S. Publications.

ALTERNATIVE FUELS AND ENGINE POLLUTION

Alternative fuels, Biodiesel production & specifications, trans esterification process, alcohol, emulsified fuels, DME, GTI, Introduction to gaseous alternative fuels, Hydrogen, production, storage, combustive properties of hydrogen, hydrogen induction systems, Compressed natural gas, production, supply, storage, filling systems, LPG. Pollutants due to transportation systems, Nature of pollutants and their formation, Local and global effects of pollutants, Effects of engine pollutants on human health, Photochemical smog, Emission regulations, regulated/unregulated pollutants, technologies to control engine pollution.