MEDI-CAPS UNIVERSITY

Knowledge is Power

Department of Mechanical Engineering

CURRICULUM AND SYLLABUS (2022-2026)

B.Tech. Mechanical Engineering

Mechanical Engineering

B.Tech.(ME)

CURRICULUM AND SYLLABUS

Vision Statement of University

Be an internationally acclaimed University recognised for its excellent teaching, research, innovation, outreach and creating top class technocrats and professionals who can serve the mankind as multi skilled global citizen.

Mission Statement of University

- Establish state-of-the-art facilities for world class education and research.
- Conduct scholarly research and creative endeavours that impact quality of life.
- Attract quality staff and students to cater for diverse needs and preferences and widen participation.
- Build a foundation for students to be successful at all levels through high-quality, innovative programs.
- Collaborate with institute, industry, and society to address current issues through research and align curriculum.
- Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.
- Encourage life-long learning and team-based problem solving through an enabling environment.

Vision of the Department:

To develop engineers of par excellence to meet the ever-changing requirements of industries, motivated towards innovation, entrepreneurship and research in mechanical and allied engineering along with strong human values and ethics for the benefit of society and nation at large.

Mission of the Department:

1. To offer a platform to the students where they will be able to groom themselves technically as industry ready professionals.
2. To develop research environment where students will be motivated to enhance their knowledge to undertake research in mechanical and allied engineering.
3. To collaborate with industries, education institutes of excellence and aluminus to share and exchange latest technology and innovation.
4. To design curriculum to motivate and sensitize students towards environmental issues and respect for human values and ethics.
5. To develop conducive academic environment in the department to attract qualified faculties members from all around the country.

Department of Mechanical Engineering

Program Education Objectives (PEOs)

PEO_{01}	To provide advanced knowledge for finding solutions of complex practical problems.
PEO_{02}	To develop research acumen for designing a system with better efficiency and performance.
PEO_{03}	To prepare students as experts with better communication skills, professional ethics and team spirit for working in multidisciplinary teams

Department of Mechanical Engineering

PROGRAMME OUTCOMES (POs)

After the completion of programme, student shall be able to: -

PO_{01}	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO_{02}	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO_{03}	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO_{04}	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO_{05}	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO_{06}	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO_{07}	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of ,and need for sustainable development.
PO_{08}	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO_{09}	**Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO_{10}	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO_{11}	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO_{12}	**Life-long learning :**Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Department of Mechanical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO_{01}	Implement the knowledge in industrial automation through specialization in CAD/CAM and Mechatronics.
PSO_{02}	Develop cost effective and sustainable energy solutions for industry and society at large through specialization in Energy Technology.
PSO_{03}	Implement the knowledge in improving industrial productivity through specialization in industrial and production engineering.

Medi-Caps University, Indore
Scheme of B.Tech. -Mechanical Engineering
For the candidates admitted in session 2022-26

Semester I

S.No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS11	Engineering Mathematics-I	3	0	0	3
2	EN3BS13	Engineering Physics	3	0	2	4
3	EN3ES17	Basic Electrical Engineering	3	0	2	4
4	EN3ES19	Engineering Graphics	2	0	2	3
5	EN3ES21	Programming-I	0	0	4	2
6	EN3ES01	Basic Civil Engineering	3	0	2	4
7	EN3NG01	Environmental Science*	2	0	0	2
		Total	**16**	**0**	**12**	**22**
		Total Contact Hours	**28**			

Semester II

S.No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS12	Engineering Mathematics-II	3	0	0	3
2	EN3BS14	Engineering Chemistry	2	0	2	3
3	EN3ES18	Basic Mechanical Engineering	3	0	2	4
4	EN3ES22	Programming-II	0	0	4	2
5	EN3HS02	Communication Skills	2	0	2	3
6	EN3ES16	Basic Electronics Engineering	3	0	2	4
7	EN3ES20	Engineering Workshop - I	0	0	2	1
8	EN3HS01	History of Science & Technology	2	0	0	2
		Total	**15**	**0**	**14**	**22**
		Total Contact Hours	**29**			

SEMESTER – III

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS15	Engineering Mathematics -III	3	0	0	3
2	ME3CO18	Manufacturing Processes - I	3	0	0	3
3	ME3CO43	Mechanics of Materials	3	0	0	3
4	ME3CO44	Engineering Thermodynamics	3	0	0	3
5	ME3CO21	Sensors and Control	3	0	2	4
6	ME3CO40	CAD LAB	0	0	2	1
7	ME3CO23	Materials and Material Testing Lab	0	0	2	1
8	ME3CO24	Python Programming for Mechanical Engineers -I	0	0	2	1
9	EN3ES25	Engineering Materials	3	0	0	3
10	EN3NG03	Soft Skills -I	2	0	0	2
11	EN3NG02	Universal Human Values & Professional Ethics	2	0	0	2
		Total	**22**	**0**	**8**	**26**
		Total Contact Hours	**30**			

SEMESTER – IV

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3CO45	Manufacturing Processes- II	4	0	2	5
2	ME3CO46	Fluid Mechanics and Machinery	4	0	2	5
3	ME3CO47	Kinematics of Machines	4	0	2	5
4	EN3HS04	Fundamentals of Management, Economics & Accountancy	3	0	0	3
5	ME3CO30	Industrial Engineering & Operations Research	3	0	0	3
6	ME3ELXX	Program Elective - I	3	0	0	3
7	EN3NG10	Soft Skills -II	2	0	0	2
		Total	**23**	**0**	**6**	**26**
		Total Contact Hours	**29**			

L : Lecture T : Tutorial P : Practical

SEMESTER – V

Sr. No.	Course Code	Course Name	L	T	P	Credits
1	ME3CO48	Data Science for Mechanical Engineers	3	0	2	4
2	ME3CO32	Heat & Mass Transfer	4	0	0	4
3	ME3CO33	Design and Simulation Lab-1	0	0	2	1
4	ME3CO34	Dynamics of Machine	4	0	2	5
5	ME3CO35	Thermal Lab	0	0	2	1
6	ME3ELXX	Program Elective - II	3	0	0	3
7	ME3ELXX	Program Elective - III	3	0	0	3
8		Open Elective I	3	0	0	3
9	EN3NG09	Soft Skills -III	2	0	0	2
		Total	**22**	**0**	**8**	**26**
		Total Contact Hours	**30**			

SEMESTER – VI

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3CO49	Computer Integrated Manufacturing	3	0	0	3
2	ME3CO50	Refrigeration & Air Conditioning	4	0	2	5
3	ME3CO38	Design and Simulation Lab -II	0	0	2	1
4	ME3CO39	Machine Design	4	0	0	4
5	ME3ELXX	Program Elective - IV	3	0	0	3
6	ME3ELXX	Program Elective - V	3	0	0	3
7		Open Elective- II	3	0	0	3
8	ME3PC11	Mini Project	0	0	4	2
9	EN3NG08	Soft Skills -IV	2	0	0	2
		Total	**22**	**0**	**8**	**26**
		Total Contact Hours	**30**			

SEMESTER – VII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3ELXX	Program Elective - VI	3	0	0	3
3		Open Elective III	3	0	0	3
4	ME3PC12	Project-1	0	0	8	4
	ME3PC03	Industrial Training	0	2	0	2
5	EN3NG06	Open Learning Courses	1	0	0	1
		Total	**7**	**2**	**8**	**13**
		Total Contact Hours	**17**			

SEMESTER VIII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3PC14	Major Project	0	0	24	12
		Total	**0**	**0**	**24**	**12**
		Total Contact Hours	**24**			

Total Credits with NG Courses	**173**

Summary of Credits

S.NO	Course Work	Total Credits (CS)	Credits as per Modal scheme (176)
1	Basic Sciences (BS)	16	10-15% (16-24)
2	Engineering Sciences (ES)	27	15-20% (24-32)
3	Humanities and Social Sciences (HS)	8	5-10% (8-16)
4	Core (CO)	62	30-40%(48-64)
5	Program Electives (EL)	18	10-15%(16-24)
6	Open Electives (OE)	9	5-10%(8-16)
7	Project Work, Seminar	20	10-15%(16-24)
8	Non Grading	13	
		173	

Medi-Caps University Indore (M.P.)

B.Tech. (I year)

Scheme (2022-26 Batch)

SEMESTER I

SNo.	Course Code	Courses	L	T	P	Credit
1	EN3BS11	Engineering Mathematics-I	3	0	0	3
2	EN3BS13	Engineering Physics	3	0	2	4
3	EN3ES17	Basic Electrical Engineering	3	0	2	4
4	EN3NG01	Environmental Science*	2	0	0	2
5	EN3ES19	Engineering Graphics	2	0	2	3
6	EN3ES21	Programming-I	0	0	4	2
7	EN3ES01	Basic Civil Engineering	3	0	2	4
		Total	**16**	**0**	**12**	**22**
		Total Contact Hours	**28**			

* Non-gradial Courses

Course Code	Course Name	Hours per week			Total	
		L	T	P	Hours	Credit
EN3BS11	**Engineering Mathematics-I**	**3**	**0**	**0**	**3**	**3**

Course Learning Objectives (CLOs):

CLO$_{01}$ To impart analytical ability of using concepts of matrices in various fields of engineering.

CLO$_{02}$ To explain the concept of Differential Calculus.

CLO$_{03}$ To discuss the concept of Integral Calculus and its applications.

CLO$_{04}$ To impart analytical ability in solving Ordinary Differential Equations of first and Higher order.

CLO$_{05}$ To impart basics of complex number and variables including concepts of analytical functions.

Unit I Matrices and Linear Systems

Rank and Nullity of a Matrix by reducing it into Echelon and Normal Forms, Solution of Simultaneous equations by elementary transformation methods, Consistency and Inconsistency of Equations, Eigen Values and Eigen Vectors.

Unit II Differential Calculus

Introduction to limit continuity, differentiability, Rolle's theorem, Mean value theorem, Taylors and Maclaurin's series expansions. Functions of Several variables, Partial differentiation, Euler's Theorem, Total Derivative, Maxima and Minima of function of two variables.

Unit III Integral Calculus

Definite Integral as a limit of sum and its application in summation of series, Beta and Gamma functions (Definitions, Relation between Beta and Gamma functions without proof, Duplication formula without proof). Multiple Integral (Double and Triple Integrals), Change the Order of Integration, Applications of Multiple Integral in Area, Volume.

Unit IV Ordinary Differential Equations

First order differential equations (Separable, Exact, Homogeneous, Linear), Linear differential Equations of second and higher order with constant coefficients**,** Homogeneous linear differential equations, Simultaneous linear differential equations**.**

Unit V Complex Variable

Basics of Complex number, Functions of complex variable: Analytic functions, Harmonic Conjugate functions, Cauchy-Riemann Equations, Complex Line Integral, Cauchy's Theorem, Cauchy's Integral Formula.

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi.
2. H.K. Dass, *Higher Engineering Mathematics, S. Chand & Company Pvt LTD., New Delhi*

References:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Pub. Co. Ltd., New Delhi.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. R.K. Jain and S.K. Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, New- Delhi.

Web Source:

1. http://nptel.ac.in/courses/111108066/
2. http://nptel.ac.in/courses/111104085/
3. https://swayam.gov.in/courses/public
4. http://nptel.ac.in/course.ph

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To illustrate the tools of matrices in solving the system of simultaneous equations,

CO_{02} To investigate the tools of differential calculus to relevant fields of engineering and can implement the concept of several variables.

CO_{03} To relate the integral calculus to relevant fields of engineering and can translate the concept of multiple integrals in finding area of regions and volume of solids.

CO_{04} To solve Ordinary Differential Equations using different methods.

CO_{05} To relate the knowledge of complex number and categorize it in solving functions of several complex numbers.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3BS13	Engineering Physics	3	0	2	4

Course Learning Objectives (CLOs):

CLO_{01} They will be able to understand the concept of Laser devices.

CLO_{02} An ability to understand the phenomena occurs in optical fibre.

CLO_{03} Students came to know about the optical phenomenon like Interference, diffraction, and polarization with their use in daily life.

CLO_{04} They will be able to learn about the quantum physics.

CLO_{05} They will be able to understand the concept of modern physics

CLO_{06} An ability to recognise the crystal structure and their basics.

CLO_{07} An ability to adapt the classical concept of oscillations.

CLO_{08} They will be able to use the acoustics nature in practical applications.

CLO_{09} Students learn the advanced concept of the superconductivity.

Unit-I Laser and Fibre Optics

Lasers: Properties of lasers, Spontaneous and Stimulated emission of radiation, Einstein's A & B co-efficient, Population inversion, Components of Laser, Ruby Laser, He-Ne Laser, Engineering applications of lasers. Fibre Optics: Fundamental idea about optical fibre, propagation of light through optical fibre acceptance angle, numerical aperture, fractional refractive index changes, V number, Classification of fibre, Engineering applications of fibre.

Unit-II Wave Optics

Interference: Fresnel's biprism experiment, Newton's ring experiment. Diffraction of light: Fraunhofer diffraction for single slit, N-slits diffraction (grating), Missing orders and Rayleigh criterion of Resolution. Polarization: General concept of Polarization, double refraction, Engineering Applications of Polarization.

Unit-III Quantum mechanics

Limitations of Classical Mechanics, De-Broglie hypothesis for matter waves, Phase and group velocity, wave packet, Heisenberg's uncertainty principle, Compton scattering, wave function, Schrodinger's Time dependent and time independent wave equation, Particle in a box problem.

Unit-IV Solid State Physics

Crystal Physics: Unit cell, Crystal System, Types of Unit cell: Simple cubic, Face centered cubic, Body centered cubic Crystal, Number of atoms per unit cell, Packing fraction in

different cubical lattices, Miller indices. Band theory of solids: Free Electron model, Band Model, Fermi level for Intrinsic and Extrinsic Semiconductors, Hall effect. Superconductivity: Zero resistance, persistent currents, superconducting transition temperature (Tc), Meissner effect, Type-I and Type-II superconductors, Engineering applications of superconductivity.

Unit- V Oscillations and acoustics

Oscillations: Concept of Simple, Periodic & harmonic Oscillation with illustrations; Differential equation of harmonic oscillator; Kinetic and potential energy of Harmonic Oscillator, compound pendulum. Acoustics: Introduction, Reverberation, Sabine's Formula, Eyring's Formula, Absorption Coefficient, Conditions for good acoustical design, Production and detection of ultrasonic waves and their applications.

Textbooks:

1. A Text book of Optics, N. Subramanyam and Brij Lal, S. Chand , New Delhi, 2010 .
2. Engineering Physics, H. K. Malik and A. K. Singh, Tata McGraw Hill New Delhi, 2010
3. Concepts of Modern Physics A. Beiser, Tata McGraw Hill New Delhi.
4. Engineering Physics, Gaur and Gupta, Dhanpat Rai Publications.

References:

1. An Introduction to Lasers- Theory and Applications. Dr. M N. Avadhanulu, Dr. R. S. Hemne S. Chand Publications.
2. Optics, A. Ghatak: 4th Edition, Tata McGraw-Hill, New Delhi 2009.
3. An Introduction to Fiber Optics, Ghatak and Thiagarajan, Cambridge University Press.
4. Solid State Physics by Kittel, Wiley India
5. A Text book of Physics – N. Gupta & S.K. Tiwary, Dhanpat Rai & Co., Delhi
6. Quantum Mechanics by Ghatak & Loknathan, Macmillian India Ltd-new Delhi Revised Edition 2019.

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01}	Understand and analyse the different types of lasers and optical fibres, operation, and its characteristics.
CO_{02}	Understand and apply various phenomenon of Interference, diffraction and polarization and their applications.
CO_{03}	Understand and apply the concept of Quantum Mechanics.
CO_{04}	Understand and examine the crystal structures and acquire the basic knowledge of various semiconductor devices.
CO_{05}	Evaluate and apply the applications of superconductivity in technology and real world.
CO_{06}	Apply basic concepts of oscillations in harmonic oscillator and compound pendulum.
CO_{07}	To analyse and design acoustics applications.

List of Practical's

List of suggestive core experiments (Any 10 experiments from the list of 16)

Laser and Fiber Optics

1. To measure the beam divergence and beam waist of laser beam.
2. To measure the numerical aperture of an optical fiber by scanning method.
3. To find the thickness of thin wire using laser.
4. To study the working of laser using PhET simulation module.
5. To establish a fiber optic analog link and study of bending loss in optical fiber.

Wave Optics

6. To determine the radius of curvature of plano convex lens using Newton's ring experiment.
7. To determine wavelength of spectral lines of mercury vapor lamp with the help of grating an spectrometer.
8. To determine the specific optical rotation of sugar solution by biquartz polarimeter.
9. To determine the wavelength of given sodium vapor lamp using Fresnel's Biprism.

Quantum Mechanics

10. Determination of Planck's constant (h) using light emitting diode (LED) of various colors.
11. To study black body Radiation by PhET Simulation.

Solid State Physics

12. To study the Hall Effect experiment and calculate the charge carrier concentration (density) of given semiconductor diode.
13. To determine the energy band gap of semiconductor diode.
14. To study V-I characteristics of semiconductor diode and Zener diode.

Oscillations and Acoustics

15. To find the frequency of AC Mains using Melde's method in longitudinal and transverse arrangement.
16. To determine the value of acceleration due to gravity (g) using compound pendulum

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3ES16	Basic Electronics Engineering	3	0	2	4

Course Learning Objectives (CLOs):

CLO_{01} To learn the basics of semiconductor materials and their usage in variety of PN junction diodes and applications of diodes

CLO_{02} To study transistor in different modes of configuration and basic biasing techniques, FET.

CLO_{03} To study of the fundamental concepts and various types of analog communication systems

CLO_{04} To study of the concept of number systems and Boolean Algebra, minimization, Logic gates and other Combinational circuits and their designing.

CLO_{05} To learn about basic Measurement & Instrument components.

Unit-I SEMICONDUCTOR DIODE
Semiconductor basics, PN Junction diode construction & working, Volt-amp characteristics, Diode current equation, Half wave rectifier, Full wave rectifier: Bridge and center tapped rectifier,Clipper and Clamper. Zener diode and zener diode-based voltage regulator, LED

Unit-II BIPOLAR JUNCTION TRANSISTOR
Construction and working of transistor, characteristics of transistor, transistor as an amplifier andswitch, transistor configurations, transistor biasing and biasing methods, basic amplifier configurations, Basic principle and working of FET and MOSFET

Unit-III BASICS OF COMMUNICATION SYSTEMS
Block schematic of communication system, Simplex and duplex systems, Modes of communication: Broadcast and point to point communication, Necessity of modulation,

Classification of modulation: Amplitude, phase, frequency modulation, sampling theorem and pulse amplitude modulation.

Unit-IV DIGITAL SYSTEM

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Boolean theorems, Minterms and Maxterms, Sum of products and products of sums, Karnaugh map Minimization, Logic gates: NOT, AND, OR, NAND, NOR, EX-OR and EX-NOR, half adder and full adder. Function and Structure of a Computer System, Von Neumann Architecture, and modern computers.

Unit-V ELECTRONICS MEASUREMENT

Introduction, Basics of Measurements, Ammeter, Voltmeter, multimeter, Signal Generators, Cathode Ray Oscilloscope: Block diagram of CRO, Construction of CRT, Deflection sensitivity and various controls, Measurement of voltage, current frequency and phase angle using CRO

Textbooks:

1. Millman and Halkias: Integrated electronics, TMH.
2. D Roy Choudhury, Digital Electronics, Vol-I & II, TMH Publication.
3. A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai.
4. Simon Haykins, Communication System, John Willy.
5. Andrew S. Tanenbaum, Structured Computer Organization, Upper Saddle River.

References:

1. Sedra and Smith: Microelectronics, Oxford Press.
2. Millman and Taub, Pulse, Digital and Switching Waveforms, MGM.
3. A.Anand Kumar: Digital Circuits, PHI.
4. Salivahanan: Electronic Circuits Analysis and Design, TMH
5. Boylestad and Nashelsky: Electronic Devices and Circuit Theory, Pearson Education.
6. B.P.Lathi, Modern Digital & Analog Communication System, TMH

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Should have the knowledge of basic semiconductor materials and their usage in variety of PN junction diodes and applications of diodes

CO_{02} Should be able to understand the concept operation of transistors and its configuration.

CO_{03} Understand and identify the fundamental concepts and various components of analog communication systems

CO_{04} Should have the knowledge of number systems and Boolean Algebra, minimization,

Logic gates and other Combinational circuits and their designing.

CO_{05} Should have understood the basics of Measurement & Instrument components.

List of Experiments:

1. To verify V-I characteristic of semiconductor & Zener diode.
2. To verify input and output waveform of half wave rectifier.
3. To verify input and output waveform of full wave rectifier.
4. To verify Input and output characteristic of BJT in CB and CE configurations.
5. Implementation of basic logic gates using Universal gates (NAND, NOR).
6. To verify half adder & full adder.
7. Study of computer system structure and main peripheral devices.
8. Study of Frequency Division Multiplexing with sinusoidal inputs / audio inputs.
9. Study of CRO and its demonstration kit.
10. Study of voltmeter and multimeter.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3NG01	Environmental Science	2	0	0	2

Course Learning Objectives (CLOs):

CLO_{01} To impart knowledge of Environment and its basic components.

CLO_{02} To build basic understanding of various effects of human activities to the environment.

CLO_{03} To understand concepts of water pollution

CLO_{04} To understand function of solid waste management

CLO_{05} To learn concepts of disaster management

Unit-I Ecosystem and Biodiversity

Concept of Ecosystem, Food Chains, Food Webs, Energy flow in an ecosystem.

Biodiversity**:** Introduction, Types, Significance and Conservation.

Unit-II Air Pollution

Causes, Effects and Control of Air Pollution, Greenhouse Effect - Climate changes and Global warming, Ozone layer depletion, Acid Rain.

Case studies on recent cases of air pollution and management.

Unit-III Water Pollution

Causes, Effects and Control of Water Pollution, DO, BOD and COD, Water sampling, Municipal water treatment.

Unit-IV Solid Waste Management

Introduction, Types of solid waste, Harmful effects of solid waste, Methods to manage and modern techniques for solid waste management.

Unit-V Disaster Management

Concept of Disaster, Types of Disaster, Pre-disaster risk and vulnerability reduction, Post disaster recovery and rehabilitation.

Case studies on recent disasters and management.

Textbooks:

1. Preeti Jain, S.L.Garg, K.G.Garg, Energy, Environment, Ecology and Society, Variety Publication.
2. Surinder Deswal, Environmental Science, Dhanpat Rai & Co. publication.
3. R. Rajgopalan , Environmental Studies, Oxford IBH Publication.

References:

1. G. M. Masters, Introduction to Environmental Science and Engineering, Pearson Education Pvt. Ltd.
2. K. De, Environmental Chemistry, New Age International.
3. Daniel D. Chiras, Environmental Science, Jones & Bartlett Ltd.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Gain knowledge of Ecosystem & Biodiversity.

CO_{02} Develop basic understanding of air pollution and its control method

CO_{03} Develop basic understanding of water pollution and its control method

CO_{04} Gain knowledge of Solid waste management and its importance.

CO_{05} Gain knowledge of Disaster Management.

Course Code	Course Name	Total Hours per week			Total	
		L	T	P	Hours	Credits
EN3ES19	**Engineering Graphics**	**2**	**0**	**2**	**4**	**3**

Course Learning Objectives (CLOs):

CLO_{01} To familiarize with the construction of geometrical figures.
CLO_{02} To familiarize with the projection of 1D, 2D and 3D elements
CLO_{03} To familiarize with the projection and sectioning of solids.
CLO_{04} To familiarize with the Preparation and interpretation of building drawing.
CLO_{05} To familiarize with the Upgraded Drawing Software and their use.

Unit -I
Drawing scales: Engineering scale, graphical scale, plain scale, diagonal scale, scale of chord.
Orthographic Projections: Reference planes, types of orthographic projections–First angle projections, Third angle projections.

Unit-II
Projections of points: Including points in all four quadrants
Projections of lines: Line parallel to reference plane, perpendicular to reference plane, inclined to one reference plane, inclined to both reference planes, traces of line.

Unit-III
Projections of Planes: Projections of Planes in different Positions, Auxiliary planes, Auxiliary Vertical Plane (AVP), Auxiliary Inclined Plane (AIP)
Projection of Solids: Classification of solid. Projections in simple and complex positions of the axis of the solid.

Unit-IV
Sections of Solids: Sectional views and true shape of the section.
Isometric Projections: Isometric view, Isometric scale to draw Isometric projection, non-Isometric lines, construction of isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, Sphere.

Unit V
Computer Aided Drawing (CAD): Introduction to AutoCAD ,2D & 3D Basics, Modify & Draw Commands Using AutoCAD, Points, Lines planes and Solids and their projections.

Textbooks:

1. N.D. Bhatt, Elementary Engineering Drawing, Chartor Publishing House.
2. D. N. Johle, Engineering Drawing, Tata McGraw-Hill Publishing Co.Ltd.
3. P.S. Gill, Engineering Graphics, S.K. Kataria andSons.

4. Warren J. Luzzader, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi.
5. F. E. Giesecke, A. Mitchell & others, Principles of Engineering Graphics, Maxwell McMillan Publishing.
6. K.C. John, Engineering Graphics for Degree, PHI Learning Pvt. Ltd.

Reference Books

1. Engineering Drawing- Basant Agarwal, TMH
2. D. M. Kulkarni, A. P. Rastogi, and A. K. Sarkar (2009), Engineering Graphics with AutoCAD, PHI Learning Private Limited, New Delhi
3. Venugopal (2010), Engineering Drawing and Graphics, 2nd edition, New Age Publications, New Delhi.
4. Trymbaka Murthy (2007), Computer Aided Engineering Drawing, I.K. International Publishers, New Delhi.
5. R.B. Choudary (2005), Engineering graphics with Auto CAD, Anuradha Publishers, New Delhi

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01} Familiarize with different drawing equipment's and technical standards and Know purpose, procedures, materials and conventional symbols used. Create and read an engineering drawing using standard views and have ability to Convert pictorial (3D) drawings to orthographic (2-D) drawings and vice versa

CO_{02} Understand the projection of points, straight lines and have the ability to convert the practical problems in to projections

CO_{03} To understand and apply concepts of the projection of simple planes & solids.

CO_{04} Understand and apply the concepts of Projection & Sections of solids & development of surfaces

CO_{05} Convert simple 2D orthographic projections into 3D isometric projections with the help of auto cad commands

List of Experiments

Preparation of drawing sheets containing the drawings for topics covered in theory.

List of Drawing Sheets (Manual)

1. Orthographic Projections
2. Projections of points & Projections of straight lines
3. Projections of planes & Projections of solids
4. Projections of sections of solids & isometric projections
5. Drawing scales

List of CAD Sheets

1. To study about special features, advantages and applications of CAD in detail.
2. To study and practice basic draw commands, modifying commands exist in the CAD.
3. To construct a diagonal scale.
4. To draw orthographic projection of given pictorial views.
5. To construct the isometric views of given geometries.


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Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3ES22	Programming-I	0	0	4	2

Course Learning Objectives (CLOs):

CLO_{01} Analyse Basics of Computers, programming environment and about different types of Programming languages.

CLO_{02} Application of various basic concepts required to create programs, use good problem solving approach.

CLO_{03} Use different control structures for conditional programming.

CLO_{04} Use of Arrays and string in different problems and also to apply different operations on arrays and strings

CLO_{05} Use the functions and procedures to solve different problems..

Unit-I Introduction to Computer and Problem Solving Methodology

Computer System, Computing Environments, Software, Types of Software and Features of Software.

Design Tools (Algorithm, Flow-Chart, Pseudo-Code).Types and Generations of Programming Languages. Compiler, Interpreter, Linker, Loader, Execution of Program. Develop an Algorithm for Simple Problems.

Unit-II Basics of Language

Character set, Identifier, Keywords, Constants, Data Types, Preprocessor Directives, Variables and Declaration, White Space and Escape Sequence, Operators and Expressions, Type Conversions, Operator Precedence and Associativity, Expression Evaluation, Input and Output Functions. Computational Problems Solving Based on above Constructs.

Unit-III Control Statements

Selection (If, Else), Conditional Operator, Iteration (For, While, Do-While), Branching (Switch, Break, Continue, Goto), Nesting of Control Statements. Problem Solving Based on Control Statements.

Unit-IV Arrays and Strings

Defining an Array, One Dimensional Array, Two Dimensional Array, Multi-Dimensional Array. Basic Array Operations and Matrix Manipulation Operations (Addition, Subtraction, and Multiplication).Problem Solving Based on Array.

Strings Definition, String Operations and String Functions. Problem Solving Based on Strings.

Unit-V Functions

Introduction, Functions Declaration, Definition, Calling, Return Statement, Parameter Passing (By Value), Recursion, Library Functions. Problem Solving Based on Functions.

Text Books:

1. Herbert Schildt, C: The complete Reference, Fourth Edition, Mc-GrawHill.
2. R. Sethi, Programming Language Concepts and Constructs, Pearson Education.
3. V. Rajaraman, Computer Programming in 'C',PHI.
4. M. Sprankle, Programming and Problem Solving, Pearson Education.
5. R.G. Dromey, How to solve it by Computer, Pearson Education.
6. E. Balguruswamy, Programming in ANSI C by, Tata Mc-GrawHill.
7. Yashavant Kanetkar, Let Us C, BPB.
8. E.Balagurusamy, Fundamentals of Computers, TMH.

References:

1. Kernighan and Ritchie , The 'C' programming language, PHI
2. Programming With C, Schaum Series.
3. A. N. Kamthane, Programming with ANSI and Turbo C, Pearson Education.

Course Outcomes (COs):

After completion of this course the students shall be able to:

- **CO_{01}** Understand Basics of Computers and Programming languages.
- **CO_{02}** Understand basic concepts of C programming language required to create programs.
- **CO_{03}** Apply different types of control structures in problem solving.
- **CO_{04}** Use of Arrays and string in different problems and also to apply different operations on arrays and strings.
- **CO_{05}** Apply and use the functions and procedures to solve different problems.

List of Practical

1. Write a program to print hello user on output screen.
2. Write a program to perform arithmetic operation on two numbers.
3. Write a program to find sum of individual digits of any three digits number.
4. Write a program to print any three digit number in reverse order.
5. Write a program to swap any two numbers using third variable and without using third variable.
6. Write a program to check given number is even or odd.
7. Write a program to check given char is vowel or consonant.

8. Write a program to check given number is positive or negative.
9. Write a program to check given year is leap year or not.
10. Write a program to check given number in range of 100-200 or not.
11. Write a program to check given number is palindrome or not.
12. Write a program to print grade of student on the basis of percentage:

a. If per greater than or equal to 75 ➔ A grade
b. If per between 60-75 ➔ B grade
c. If per between 50-60 ➔ C grade
d. If per between 40-50 ➔ D grade
e. If per less than 40 ➔ Fail

13. Write a program for addition subtraction multiplication division using switch case.
14. Write a program to print table of any number.
15. Write a program to calculate factorial of any number.
16. Write a program to print series of alphabet.
17. Write a program to print Fibonacci series.
18. Write a program to check given number is perfect or not
19. Write a program to check given number is prime or not.
20. Write a program to check given number is Armstrong or not
21. Write a program to print number in word in between 1-5. Like (1 =one)
22. Write a program to check given char is vowel or consonant.
23. Write a program to print name of month according to number.
24. Write a program for convertor

a. For currency convertor
b. For temperature convertor
c. For weight convertor
d. For length convertor
e. For time convertor
f. For energy convertor

25. Write a program to print series of number from 1-100 without using loop.
26. Write a program to find maximum & minimum number from array.
27. Write a program to check how many numbers is prime & not prime in a list
28. Write a program to check how many digits at each index of array.
29. Write a program to check (search) given number is present or not present in list.
30. Write a program to arrange (sort) array elements in ascending or descending order.
31. Write a program to print a 2*2 matrix.
32. Write a program to find sum of two matrix.
33. Write a program to find multiplication of two matrix.
34. Write a program of string functions.
35. Write a function to find sum of two numbers.
36. Write a function to calculate factorial of any number.
37. Write a function for call by value to find sum of two numbers.

38. Write a function to pass an integer array as an arguments and find sum of array elements

39. Write a function to pass a char array as an argument and find length of string.
40. Write a recursive function to calculate factorial of any number.
41. Write a program to find the no of char no of word and no of lines from given text input.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3ES01	Basic Civil Engineering	3	0	2	4

Course Learning Objectives (CLOs):

CLO_{01} To give the knowledge of various building and general construction materials such as bricks, stones, timber, cement, steel and concrete & their properties and application.

CLO_{02} To provide basic understanding of the forces and its components, stresses, strains and the modulus of elasticity of the different construction materials.

CLO_{03} To understand the components of the building such as beams, columns, foundations, slabs and different types of soils and their bearing capacities.

CLO_{04} To provide basic knowledge about principles of surveying for a location, and its application in execution of engineering projects, various instruments used for surveying such as chains, tapes, compass, theodolite and auto level.

CLO_{05} To understand various aspects of structural members and application of loads, shear force & bending moment in the field of civil engineering.

Unit I Building Construction Material

Role of Civil Engineer in the construction of buildings, dams, expressways, and infrastructure projects for 21st century. Importance of an inter- disciplinary approach in engineering Building Materials: Bricks composition, classifications, properties and uses. Stone classification of rocks, quarrying, and Dressing properties uses. Timber properties uses plywood. Cement: grades, types, properties, uses. Steel: types, mild steel, medium steel, hard steel, properties, uses, market forms. Concrete: grade designation, properties, uses.

Unit II Surveying and levelling

Surveying-classification, general principles of surveying–Basic terms and definitions of chain, Chain survey, Compass survey and Levelling, Uses of surveying, Contours their characteristics and uses.

Unit III Building Components

Site selection, General Classification and building components. Soils: types and bearing capacity of soils, Foundation: functions and classifications. Flooring: requirements and selection types, Roof - types and requirements.

Unit IV Forces & Properties of Material

Forces and its components, Resolution and summation of forces, Lami's Theorem, Stress, Strain types, Hook's law, Three moduli of elasticity, poisons ratio, relationship, factor of safety.

Unit V Shear force and Bending moment

Introduction of shear force and bending moment and their sign conventions, Types of loads, Types of beams, Types of supports; Shear force and bending moment diagrams for simply supported, overhang and cantilever beams subjected to any combination of point loads, uniformly distributed load and point moment; Relationship between load, shear force and bending moment.

Text Books

1. S.C. Rangwala, Building materials, Charotar Publishing House, Pvt. Limited.
2. S.Ramamrutham , Basic Civil Engineering and Engineering Mechanics, Dhanpat Rai.
3. K.K.Dwivedi & K.K. Shukla, Basic Civil Engineering & Engineering Mechanics, Dhanpat Rai & Co.(Revised).

References

1. I.K.V.B. Raju and P.T. Ravichandran, Basics of Civil Engineering, Ayyappa Publications, Chennai.
2. S.Gopi, Basic Civil Engineering, Pearson Publishers.
3. M.S. Palanichamy, Basic Civil Engineering, Tata Mc Graw Hill

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Students will be able to recognize the civil engineering works and conversant about different construction materials and their uses.

CO_{02} Student will be able to differentiate force, pressure and stresses.

CO_{03} Students will be able to know the different building component and its importance.

CO_{04} Students will be conversant about vertical and horizontal variation of different terrains.

CO_{05} Students will be able to apply the theoretical knowledge about structural elements in practical manner.

List of Experiments

1. To determine particle size distribution & fineness modulus of coarse and fine aggregates.
2. To determine standard consistency of cement paste. -
3. To determine initial and final setting times for cement by using Vicat's apparatus.
4. To determine the workability of fresh concrete of given proportion by slump cone test.
5. To determine the area of land by chain surveying.
6. To perform traverse surveying with prismatic compass check for local attraction and determine corrected bearing and to balance the traversing by Bowditch'srule.
7. To perform levelling by height of Instrument method.
8. To perform levelling by rise and Fall method.
9. To perform Plane Table Surveying work by (A) Radiation method and (.B) Intersection methods.
10. To measure horizontal and vertical angle sin the field by using Theodolite.

SEMESTER II

SNo.	Course Code	Courses	L	T	P	Credit
1	EN3BS12	Engineering Mathematics-II	3	0	0	3
2	EN3BS14	Engineering Chemistry	2	0	2	3
3	EN3ES18	Basic Mechanical Engineering	3	0	2	4
4	EN3ES22	Programming-II	0	0	4	2
5	EN3HS02	Communication Skills	2	0	2	3
6	EN3ES16	Basic Electronics Engineering	3	0	2	4
7	EN3ES20	Engineering Workshop – I	0	0	2	1
8	EN3HS01	History of Science and Technology	2	0	0	2
		Total	**15**	**0**	**14**	**22**
		Total Contact Hours	**29**			

Course Code	Course Name	Hours per week			Total	
		L	T	P	Hours	Credit
EN3BS12	**Engineering Mathematics-II**	**3**	**0**	**0**	**3**	**3**

Course Learning Objectives (CLOs):

CLO_{01} To illustrate knowledge of Laplace Transform and investigate its application.

CLO_{02} To explain the concept of Fourier Series and Fourier Transform.

CLO_{03} To illustrate the concept of Partial Differential Equations.

CLO_{04} To impart the knowledge of Vector Calculus.

CLO_{05} To discuss numerical methods and to outline its application in solving algebraic, transcendental equations and system of linear equations.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO1 To impact mathematical models involving ordinary and partial differential equations with given boundary condition which is helpful in all engineering and research work.

CO2 To examine the general mathematical concepts required for the field regarding Laplace and Fourier Transform.

CO3 To compare and contrast importance of partial differential equations in physical problems.

CO4 To prioritize derivatives of vector- point functions, gradient functions, evaluate integral of functions over curves, surfaces and domains in two and three dimensional.

CO5 To examine numerical techniques and investigate its application in solving algebraic and transcendental equations.

Unit I Laplace Transform

Introduction of Laplace Transform, Laplace Transform of elementary functions, properties of Laplace Transform, Inverse Laplace transform and its properties, Convolution theorem, Applications of Laplace Transform to solve the Ordinary Differential Equation, Laplace transform of Unit step function and Impulse function.

Unit II Fourier Series and Fourier Transform

Introduction of Fourier series, Fourier series for Discontinuous functions, Fourier series for Even and Odd function, Half range series, Fourier Transform, Sine and Cosine Transform.

Unit III Partial Differential Equations

Definition, Formulation, Solution of Partial Differential Equations (By Direct Integration Method and Lagrange's Method), Non-Linear Partial Differential Equations of First order {Standard form I, II, III & IV), Charpit's method. Partial Differential Equations with Constant Coefficients (Higher Orders Homogeneous), Method of Separation of Variables.

Unit IV Vector Calculus

Scalar and Vector fields, Vector Differentiation, Laplacian operator, Gradient, Divergence and Curl, Line and surface integrals, Green's theorem, Gauss Divergence theorem, Stoke's theorem.

Unit V Numerical Analysis

Errors and Approximations, Solution of Algebraic and Transcendental Equations (Regula Falsi, Newton-Raphson and Iterative methods), Solution of Simultaneous linear equations by Gauss Elimination, Gauss Jordan, Jacobi's and Gauss-Siedel Iterative methods.

Textbooks:

1. B.S. Grewal, *Higher Engineering Mathematics*, Edition-43, Khanna Publishers, New Delhi.
2. H. K. Dass, *Higher Engineering Mathematics,S. Chand & Company Pvt LTD., New Delhi*

References:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing CompanyLtd., New Delhi.
2. Shanti Narayan, A textbook of Vector Calculus, S. Chand & Co., New Delhi.
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 1999.

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2. nptel.ac.in/courses/111105035/22
3. https://swayam.gov.in/courses/public
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Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3BS14	Engineering Chemistry	2	0	2	3

Course Learning Objectives (CLOs):

CLO_{01} To gain fundamental knowledge of the principles related to, so as to meet the challenging requirements of students in chemistry studies.

CLO_{02} To attain awareness in students about current & new issues in the fields of chemistry.

CLO_{03} To make students understand about the present needs without compromising on theability of future generations to meet their own needs for proper engineering, relevanteducation efficient management of resources.

CLO_{04} To increase curiosity and give them awareness about practical knowledge of variouslaboratory methods among the students regarding the course.

Unit-I Lubricants

Introduction, Classification of lubricants, Mechanism of lubrication, Properties and Testing of lubricating oils (Flash and Fire point, Cloud and Pour point, Viscosity and Viscosity Index, Neutralization number, Saponification Number, Steam Emulsification Number, Aniline Point, Iodine Value), Numerical problems based on testing methods.

Unit -II Polymer

Introduction and Classification of polymer, Preparation, Properties andUses of the following- Polythene, PVC, Teflon, Nylon 66, Bakelite, Silicone resin, Natural and Synthetic Rubber, Vulcanization of Rubber, Biopolymers, Biodegradable polymers.

Unit -III New Engineering Materials

Introduction, PropertiesandApplications of - Superconductors, Optical Fiber, Fullerenes, Graphene, Carbon nanotubes, Nanowires.

Unit -IV Instrumental Techniques in Chemical Analysis

Spectroscopy, Electromagnetic spectrum, Beer &Lambert's Law and its limitations,Principle, Instrumentation and Applications of-UV-VisibleSpectroscopy, IR Spectroscopy, Gas Chromatography.

Unit- V Electrochemistry

Concept of Enthalpy, Entropy and Free energy, EMF, Applications of EMF measurements, Corrosion- Definition, Types, Causes and Protection from corrosion.

Text Books:

1. Preeti Jain, Anjali Soni, Jeetendra Bhawsar, A text book of Engineering Chemistry, 1st edition, Manthan Publication, 2016.
2. Preeti Jain, S L Garg, Engineering Chemisty, 4th edition, Variety Publication.
3. Shashi Chawla, Engineering Chemistry, 11th edition, Dhanpat RaiPublications.

Reference Books:

1. P C Jain, Monika Jain, Engineering Chemistry, Dhanpat RaiPublications.
2. S. S.Dara, A Text Book of Engineering Chemistry, S. Chand & Company.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To Understand the lubricants, their mechanism and practically analyze the properties of lubricants.
CO_{02} Will acquire betterment in lifestyle by understanding the need of bio polymers in the current scenario and replacing synthetic polymers with its bio-polymer substitute.
CO_{03} Will get familiarised with new engineering materials and their commercial applications.
CO_{04} Will get knowledge of using instrumental techniques and their applications for determination of chemical structure of any compound.
CO_{05} Identify various types of corrosion and methods to protect the metallic structures from corrosive environment.

List of Practicals:

Volumetric Analysis:

1.To determine Hardness of given water sample by Complexometrictitration.
2.To determine total and mixed Alkalinity of given water sample using phenolphthalein and methyl orange asindicator.
3.To determine strength of unknown FAS solution by Redox titration using N-Phenyl anthranilic acid as internalindicator.
4.To determine strength of unknown $CuSO_4$ solution by Iodometric titration using Starch as internalindicator.
5.To determine Chloride content of water sample by Mohr's method (Argentometrictitration).

Fuel Testing:

1.Todeterminemoisturecontentingivensampleofcoalbyproximateanalysis.

2.Todeterminevolatilecontentingivensampleofcoalbyproximateanalysis.
3.Todetermineashcontentingivensampleofcoalbyproximateanalysis.
4.To determine percentage carbon content of coal by proximate analysis.

Lubricant Testing:

1. To determine penetration number of grease by Cone Penetrometerapparatus.
2. To determine flash and fire point of given oil sample by Cleveland's open cup apparatus.
3. To determine flash point of given oil sample by Penskey Marten's close cup apparatus.
4. To determine flash point of given oil sample by Abel's Closecup apparatus.
5. To determine Steam emulsification number of givenlubricant.
6. To determine Aniline point of given oilsample.
7. To determine Cloud and Pour point of given lubricatingsample.
8. To study rate of change of viscosity with temperature of the given lubricating oil by meansof Redwood Viscometerno.1
9. To study rate of change of viscosity with temperature of the given lubricating oil by means of Redwood Viscometer no.2.

Electrochemistry:

Variation of cell potential in $Zn/Zn^{2+}//Cu^{2+}/Cu$ with change in concentration of electrolytes ($CuSO_4$ or $ZnSO_4$) at room temperature.

Kinetics:

Effect of concentration and temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid.

Course Code	Course Name	Hours per Week			Total	
		L	T	P	Hours	**Credits**
EN3ES18	**Basic Mechanical Engineering**	**3**	**0**	**2**	**5**	**4**

Course Learning Objectives (CLOs):

CLO_{01} To understand the properties of materials and their behavior with variation in temperature and Load. To understand different measuring instruments used in engineering applications.

CLO_{02} To understand the basic laws of thermodynamics and their applications in engineering, refrigeration cycles and properties of refrigerants.

CLO_{03} To understand Construction and Working of I. C. Engines.

CLO_{04} To understand Construction and Working of Steam Generators

CLO_{05} To understand the concepts of Centroid & Moment of Inertia and of plane areas and different theorems of moment of Inertia

Unit-I Materials & their mechanical properties
Classification of Engineering material and their mechanical properties, Composition of cast iron and carbon steels and their application. Stress-strain diagram, Hooks law and modulus of elasticity.Tensile, shear, hardness, and fatigue testing of materials.

Unit-II Thermodynamics
Thermodynamic properties and systems, First of thermodynamics, thermal processes at constant pressure, volume. Second law of thermodynamic, enthalpy, entropy, heat engine, heat pump, refrigerator and their numerical.

Unit-III I.C. Engines
Description and working of four stroke petrol engines, two stroke petrol engines, four stroke diesel engines and two stroke diesel engines, and its efficiency relative merits and demerits.

Unit-IV Steam generators
Definition, Classification, general study of Cochran, Lancashire and Locomotive boilers, boilers mountings and accessories. Steam properties and boiler performance. Draught Classification, Calculation of Chimney height, boiler efficiency and numerical. Unit V: Centroid & Moment of Inertia Location of centroid and Moment of Inertia of plane areas, Perpendicular Axis and Parallel Axis theorems.

Unit V Centroid & Moment of Inertia
Location of centroid and Moment of Inertia of plane areas, Perpendicular Axis and Parallel Axis theorems.

Textbooks:

1. R.K. Rajput, Basic Mechanical Engineering, Laxmi Publication.
2. P.K. Nag, Engineering Thermodynamics, McGraw Hill.
3. R.K. Bansal, Engineering Mechanics, Laxmi publications.

References:

1. Anand K Bewoor, Vinay A Kulkarni, Ist edition, Metrology & Measurement, McGraw Hill.
2. Cengel and Boles, Thermodynamic, An Engineering Approach in S.I Unit, McGraw Hill.

S.S. Bhavikatti and K.G.Rajashekarappa, Engineering Mechanics, New age international limited.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Students will be able to understand the engineering materials, their properties, Iron-Carbon Diagram and Stress-Strain Curve, Measuring Equipment's and Testing Machines.

CO_{02} Student will be thorough with the basic laws of thermodynamics and their applications in engineering also know about Refrigeration cycles and properties of refrigerants.

CO_{03} Students will be able to understand the construction and working of I.C. Engines .

CO_{04} Students will be able to understand the construction and working of Steam Generators

CO_{05} Students will be able to determine the Centroid & Moment of Inertia of areas/composite sections.

List of Experiments

1. Measurements using Vernier calliper & micrometer.
2. Measurements using dial gauges and combination set.
3. Measurements using slip gauges & sine-bar.
4. Tensile Testing of standard mild steel specimen on UTM.
5. To determine the hardness number by using Brinell Hardness Testing Machine.
6. Study of 2-stroke petrol and diesel engine.
7. Study of 4-stroke petrol and diesel engine.
8. Study of different type of boilers.
9. Study of different type of boilers mounting & accessories.
10. To find the centroid of different plane laminas.


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Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3ES22	Programming-II	0	0	4	2

Course Learning Objectives (CLOs):

CLO_{01} Understand Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Accessing arrays, strings through pointers.

CLO_{02} Declaration and use structures, perform operations on structures, passing structures as function arguments. type defining structures.

CLO_{03} Use Function declaration, function definition, function call, Passing arguments to a function, by value, by reference. Scope of variable names, creation of header files

CLO_{04} Use calloc, malloc, realloc dynamic memory.

CLO_{05} Apply Input-output using files in C, Opening, closing and reading from files. Programming for command line arguments.

CLO_{06} Apply graphics functions to create pictorial representation and animations

Unit-I Pointers

Introduction to Pointers (Declaration and Initialization), Double Pointer, Pointers and Array, Pointers and Functions, Operations on Pointers.

Unit-II User Defined Data Types

Defining a Structure, Declaration of Structure Variables, Initialization of Structure Variables, Accessing Structure Members, Storage of Structures in Memory Array within a Structure, Array of Structure, Pointer Structure, Passing Structure to a Function, Structure within a Structure. Define Union, Structure versus Union, Working with Union, Initializing Union, Enumerated Data Type.

Unit-III Pre-processor and Memory Allocation

Pre-processor Directives, Macro and Macro Expansions, File Inclusions, Conditional Compilation, Stringification (#) and Token Passing Operator (##), Type Def, Command Line Argument, Dynamic Memory Allocation. malloc(), calloc(), realloc(), free(), Core Dump, Memory Leak, Dynamic 1D and 2D Arrays. Header Files and Their Creations.

Unit-IV File Handling

File Concept, File Pointer and File Handling Operations Using files in C, Buffer and Streams, Working with Text Files and Binary Files, File Operations using std. Library and System Calls, File Management I/O Functions, Random Access Files.

Unit-V Graphics Programming

C Header Files for handling graphics and initializing graphics mode, Understand Coordinate system, Function to Draw Lines,Circle, Arc, Ellipse, pieslice, sector, Rectangle, Bar, 3-D Bars & Polygon, Color Spraying: filling Ellipse, polygons and flooding the fills, Filling Styles and Patterns, Understand Animation, Function to create Animation, Traffic Light and Moving Car Simulation.

Text Books:

1. Herbert Schildt, C: The complete Reference, Fourth Edition, Mc-Graw Hill.
2. R. Sethi, Programming Language Concepts and Constructs, Pearson Education.
3. V. Rajaraman, Computer Programming in 'C', PHI.
4. M. Sprankle, Programming and Problem Solving, Pearson Education.
5. R.G. Dromey, How to solve it by Computer, Pearson Education.
6. E. Balguruswamy, Programming in ANSI C by, Tata Mc-Graw Hill.
7. Yashavant Kanetkar, Let Us C, BPB.
8. E. Balagurusamy, Fundamentals of Computers, TMH.
9. AL Stevens, C Database Development, MIS Press.

References:

1. Kernighan and Ritchie, The 'C' programming language, PHI.
2. Programming With C, Schaum Series.
3. A. N. Kamthane, Programming with ANSI and Turbo C, Pearson Education.

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01} Apply Pointers, Pointer Arithmetic and Accessing arrays, strings through pointers.
CO_{02} Use different user defined data types like structures, union and enum.
CO_{03} Understand and Use of dynamic memory allocation and preprocessor directives.
CO_{04} Use the concepts of file handing.
CO_{05} Use Graphics programming to draw and use different shapes.

List of Practical

1. Program to create, initialize, assign and access a pointer variable.
2. Program to swap two numbers using pointers.
3. Program to change the value of constant integer using pointers.

4. Program to print a string using pointer.
5. Program to count vowels and consonants in a string using pointer.
6. Program to find sum of elements of array using pointer.
7. Program to swap two numbers using pointers.
8. Compare strings using pointer
9. Find smallest number in array using pointer.
10. Find largest element in array using pointer.
11. Find sum of all matrix elements using pointer.
12. Program to create a pointer array store elements in it and display.
13. Program to demonstrate function pointers.
14. Program to perform Addition Subtraction Multiplication Division using array of function pointers.
15. Program to display details of student two (Name, roll no, marks) using structure.
16. Program to display details of employee using array of structure.
17. Program to access member of structures using pointers.
18. Program for passing structure to a function.
19. Program for returning a structure from a function.
20. Program to display details of student two (Name, roll no, marks) with the help of union.
21. Program to demonstrate the memory allocation in structure and union.
22. Program to demonstrate malloc and calloc.
23. Program to allocate memory of array at run time.
24. Program to print the day of week.
25. Program to print month of a year.
26. Program to calculate area of circle using macro.
27. Program to calculate area of circle using macro function.
28. Program to create a header file and use it in a program.
29. Program to demonstrate file operation.

a. Creating a new file
b. Opening an existing file
c. Closing a file
d. Reading from and writing information to a file

30. Program to count number of words, number of character and number of lines from a given text file.
31. Program in C to delete a specific line from a file.
32. Write a program in C to append multiple lines at the end of a text file.
33. Write a program in C to copy a file in another name.
34. Write a program in C to merge two files and write it in a new file.
35. Write a program in C to encrypt a text file.
36. Write a program in C to decrypt a previously encrypted file.

37. Write a program in C to remove a file from the disk.

38. Write a program to draw a circle and fill blue color in it.

39. Write a program to draw a rectangle with diagonal and fill different colors in both halves.

40. Write a program to move a circle using suitable annimations.

41. Write a program to implement traffic signal.

Write a pogram to simulate a moving car. Draw car using simple shapes like line, circle and polygon.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3HS02	COMMUNICATION SKILLS	2	0	2	3

Course Learning Objectives (CLOs):

CLO_{01} To develop, enhance and demonstrate LSRW Skills.

CLO_{02} To enable students to acquire oral presentation skills.

CLO_{03} To prepare students to become more confident and active participants in all aspects of their undergraduate programs

CLO_{04} To enable students with good vocabulary, grammar and writing skills.

CLO5 To enable students to distinguish between general and technical communication and understand its importance

Unit-I

Grammar and Vocabulary Development: Applied Grammar and usage, Parts of Speech, Articles, Tenses, Subject-Verb Agreement, Prepositions, Active and Passive Voice, Clauses, modals, Reported Speech: Direct and Indirect, Sentence Structure, Punctuations, common errors.

Unit-II

Using Dictionaries and Thesaurus, Synonyms, Antonyms, Homophones, One Word Substitution, Affixation: Prefixes & Suffixes, Basic Grammar & Vocabulary Practice, Synonyms, Antonyms, Analogies, Sentence Completion, Correctly Spelt Words, Idioms, Proverbs, and Derivation from root words, Jargon, Scientific Jargon, Vocabulary Practice.

Unit-III

Developing Reading and Listening Skills: Reading Comprehension, Process, Active & Passive Reading, Reading Speed Strategies, Benefits of effective reading, notemaking, note - taking, Reading comprehension of technical material and SQ3R reading technique. Listening Skills: Meaning, process hearing and listening, types, barriers, importance.

Unit-IV

Developing Writing Skills: Planning, Drafting & Editing, Writing with style, rightwords selection, writing effective sentences, developing logical paragraphs, art of condensation, précis, essay, technical definition and technical description. Formal and Informal Letters: Letter to the Editors, Municipal corporation, Bank Managers etc.

Unit-V

Speaking Skills Oral Presentation: Preparation, Delivery using Audio – Visual Aids with stress on body language and voice modulations. (Topics to be selected by the Instructor.) Phonetic Symbols, Pronunciations.

Text Books:

1. P.C,Wren and N.D.V. Prasada Rao, High School English Grammar & Composition, S Chand and Co Pvt Ltd.
2. S. Kumar and P. Lata, English for Effective Communication, Oxford UP, New Delhi.
3. A.J. Thompson and A. V. Martinet, A Practical English Grammar, Oxford UP, New Delhi.
4. U. S. Rai and S.M, Rai, Effective Communication, Himalaya Publishing House.

References:

1. A.C. Gimson, An introduction to the Pronunciation of English, ELBS.
2. S. Greenbaum, Thw Oxford English Grammer, Oxford University Press.
3. K.Mohan and M. Raman, Effective English Communication, Tata Mc-Graw Hill.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} The students will be able to enhance confidence in their ability to read, comprehend, organize, and retain written and oral information.

CO_{02} The students will be able to distinguish between general and technical communication and understand its importance

CO_{03} The students will be able to improve upon their language skills, communication skills, group discussion, and personality development and confidence level.

CO_{04} The students will be able to bridge the language gap which is vital to their success

CO_{05} Students will be able to communicate effectively.

List of Experiments (if applicable): List of Practicals:

- JAM
- Debates
- Role plays
- GDs
- Extempore
- Story writing
- Picture description
- Symposium
- Oral presentation
- Phonetics practice
- Book Reviews

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3ES16	Basic Electronics Engineering	3	0	2	5

Course Learning Objectives (CLOs):

CLO_{01} To learn the basics of semiconductor materials and their usage in variety of PN junction diodes and applications of diodes

CLO_{02} To study transistor in different modes of configuration and basic biasing techniques, FET.

CLO_{03} To study of the fundamental concepts and various types of analog communication systems

CLO_{04} To study of the concept of number systems and Boolean Algebra, minimization, Logic gates and other Combinational circuits and their designing.

CLO_{05} To learn about basic Measurement & Instrument components.

Unit-I SEMICONDUCTOR DIODE
Semiconductor basics, PN Junction diode construction & working, Volt-amp characteristics, Diode current equation, Half wave rectifier, Full wave rectifier: Bridge and center tapped rectifier,Clipper and Clamper. Zener diode and zener diode-based voltage regulator, LED

Unit-II BIPOLAR JUNCTION TRANSISTOR
Construction and working of transistor, characteristics of transistor, transistor as an amplifier andswitch, transistor configurations, transistor biasing and biasing methods, basic amplifier configurations, Basic principle and working of FET and MOSFET

Unit-III BASICS OF COMMUNICATION SYSTEMS
Block schematic of communication system, Simplex and duplex systems, Modes of communication: Broadcast and point to point communication, Necessity of modulation, Classification of modulation: Amplitude, phase, frequency modulation, sampling theorem and pulse amplitude modulation.

Unit-IV DIGITAL SYSTEM
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Boolean theorems, Minterms and Maxterms, Sum of products and products of sums, Karnaugh map Minimization, Logic gates: NOT, AND, OR, NAND, NOR, EX-OR and EX-NOR, half adder and full adder. Function and Structure of a Computer System, Von Neumann Architecture, and modern computers.

Unit-V ELECTRONICS MEASUREMENT
Introduction, Basics of Measurements, Ammeter, Voltmeter, multimeter, Signal Generators, Cathode Ray Oscilloscope: Block diagram of CRO, Construction of CRT, Deflection

sensitivity and various controls, Measurement of voltage, current frequency and phase angle using CRO

Textbooks:

6. Millman and Halkias: Integrated electronics, TMH.
7. D Roy Choudhury, Digital Electronics, Vol-I & II, TMH Publication.
8. A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai.
9. Simon Haykins, Communication System, John Willy.
10. Andrew S. Tanenbaum, Structured Computer Organization, Upper Saddle River.

References:

7. Sedra and Smith: Microelectronics, Oxford Press.
8. Millman and Taub, Pulse, Digital and Switching Waveforms, MGM.
9. A.Anand Kumar: Digital Circuits, PHI.
10. Salivahanan: Electronic Circuits Analysis and Design, TMH
11. Boylestad and Nashelsky: Electronic Devices and Circuit Theory, Pearson Education.
12. B.P.Lathi, Modern Digital & Analog Communication System, TMH

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01} Should have the knowledge of basic semiconductor materials and their usage in variety of PN junction diodes and applications of diodes

CO_{02} Should be able to understand the concept operation of transistors and its configuration.

CO_{03} Understand and identify the fundamental concepts and various components of analog communication systems

CO_{04} Should have the knowledge of number systems and Boolean Algebra, minimization, Logic gates and other Combinational circuits and their designing.

CO_{05} Should have understood the basics of Measurement & Instrument components.

List of Experiments:

1. To verify V-I characteristic of semiconductor & Zener diode.
2. To verify input and output waveform of half wave rectifier.
3. To verify input and output waveform of full wave rectifier.
4. To verify Input and output characteristic of BJT in CB and CE configurations.
5. Implementation of basic logic gates using Universal gates (NAND, NOR).
6. To verify half adder & full adder.
7. Study of computer system structure and main peripheral devices.
8. Study of Frequency Division Multiplexing with sinusoidal inputs / audio inputs.
9. Study of CRO and its demonstration kit.
10. Study of voltmeter and multimeter.

Course Code	Course Name	Total Hours per week			Total	
		L	T	P	Hours	Credits
EN3ES20	**Engineering Workshop -I**	**0**	**0**	**2**	**2**	**1**

Course Learning Objectives (CLOs):

CLO_{01} To familiar with Lathe, Drilling, Milling and shaping machines.

CLO_{02} The basic law of physics and their utilization in engineering.

CLO_{03} To understand different primary manufacturing process.

CLO_{04} To understand different metal joining process.

CLO_{05} To identify different tools used in basic manufacturing process.

Unit-I Introduction and Demonstration: - Introduction to various shops / sections and workshop layouts. Safety norms to be followed in a workshop.
Carpentry Shop: Introduction of Tools & operations, Types of woods & their applications, Types of Carpentry tools and their uses, Carpentry Joints, carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, types of woods and carpentry hardware.

Unit-II Fitting Shop: Introduction of Tools & operations, Types of Marking tools & their uses, Types of fitting cutting tool & their uses, fitting operations such as chipping, filing, scraping, grinding, sawing, marking, drilling, tapping

Unit-III Foundry Shop: Pattern Making: Study of Pattern materials, pattern allowances and types of patterns. Core box and core print. Use and care of tools used for making wooden patterns.
Molding: Properties of good mould & Core sand, Composition of Green, Dry and Loam sand. Methods used to prepare simple green sand mould using single piece and split patterns.
Black Smithy Shop: Use of various smithy tools. Forging operations: Upsetting, drawing down, Fullering Swaging and Cutting down.

Unit-IV: Welding Shop: Study and use of tools used for Brazing, Soldering, Gas & Arc welding. Preparing Lap & Butt joints using gas and arc welding methods, Study of TIG & MIG welding processes. Safety precautions.

Unit V: Machine Shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools). Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling, and parting. Demonstration and applications of drilling machine, Demonstration of CNC Machines

Textbooks:

1. B.S. Raghuwanshi, Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. R.S. Khurmi, Workshop Technology, S. Chand and Co.
3. S.K. Hajra Choudhary, A.K. Hajra Choudhary and Nirjhar Roy, Elements of Workshop Technology, vol. I Media promoters and Publishers Pvt. Ltd
4. R.K. Bansal, Engineering Mechanics, Laxmi publications.

Reference Books:

1. W. A.J. Chapman, Workshop Technology, 1998, Part -1, 1st South Asian Edition, Viva Book Pvt. Ltd.
2. P.N. Rao, 2009, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill Publishing Company.
3. Dr. S.K. Sinha , CNC programming — Golgotia publication.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand the engineering materials, their properties, and their utilization in manufacturing tool and other equipment's.

CO_{02} Understand the primary manufacturing process.

CO_{03} Understand the basic operation involve in casting.

CO_{04} Understand the basic process of forging.

CO_{05} Basic knowledge of simple cutting, holding. Marking and striking tool.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3HS01	History of Science and Technology	2	0	0	2

Course Learning Objectives (CLOs):

CLO_{01} To know the historical perspective of science and technology in India, its roots and its role.

CLO_{02} To know how research and development field is progressing in India.

CLO_{03} To know what were the policies and plans are proposed after independence to be technologically sound.

CLO_{04} To Know what were the developments done in major areas of science & technology.

CLO_{05} To know the relationship between the technologies.

Unit-I Historical Perspective

Nature of science and technology, Roots of science and technology in India, Role of Scienceand Scientists in society, Science and Faith.

Unit-II Research and Development (R&D) in India

Science and Technology Education, Research activities and promotion of technology development, Technology mission, Programs aimed at technological self-reliance, activities of council of scientific and industrial research (CSIR).

Unit-III Policies and Plans after Independence

Nehru's vision of science for independent India, Science and technology developments in the new era, science and technology developments during the Five-Year Plan Periods and scienceand technology policy resolutions.

Unit-IV Science and Technological Developments in Major Areas

Space – Objectives of space programs, Geostationary Satellite Services – INSAT system and INSAT services remote sensing applications, Launch Vehicle Technology. Ocean Development.Objectives of ocean development, marine research. Biotechnology - Applications of biotechnology in medicine, agriculture, food, and fuel. Energy – Research and development in the field of nonconventional energy resources, India's nuclear energy program.

Unit-V Nexus between Technologies

Transfer of Technology – Types, Methods, Mechanisms, Process, Channels and Techniques, Appropriate technology, Technology assessment, Technological forecasting, Technological innovations and barriers of technological change.

Textbooks:

1. K. Rajaram, Science and Technology in India, Published and Distributed by SpectrumBooks (P) Ltd., New Delhi.
2. M. Srinivasan, Management of Science and Technology (Problems & Prospects),East- West Press (P) Ltd., New Delhi.
3. G.R. Kohili, The Role and Impact of Science and Technology in the Development ofIndia, Surjeet Publications.
4. Government of India, Five Year Plans, Planning Commission, New Delhi.
5. K.D. Sharma, and M.A. Qureshi, Science, Technology and Development, SterlingPublications (P) Ltd., New Delhi.

References:

1. Suvobrata Sarkar , History of Science, Technology, Environment, and Medicine in India, Published by Routledge India.
2. Sabareesh P.A. , A Brief History Of Science In India. Published by Garuda rakashan.
3. G. Kuppuram, K. Kumudamani, History of Science and Technology in India, Published by Sundeep Prakashan.

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01} Student will be aware about the ancient India & the existence of science & technology in that era & how it is reciprocated.

CO_{02} Student will be aware about the upliftment done in the field of R & D after independence.

CO_{03} Student will come to know about the plans and policies that brought about radical changes for the growth of science in India.

CO_{04} Student will come to know about the major areas of the applied science and their existence. And can set the relationship between the technologies.

CO_{05} Students will understand the need of technology transfer, its types and processes.

Scheme of B.Tech -Mechanical Engineering 2022 Batch						
SEMESTER – III						
Sr.No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1	EN3BS15	Engineering Mathematics -III	3	0	0	3
2	ME3CO18	Manufacturing Processes - I	3	0	0	3
3	ME3CO19	Mechanics of Materials	3	0	0	3
4	ME3CO20	Engineering Thermodynamics	3	0	0	3
5	ME3CO21	Sensors and Control	3	0	2	4
6	ME3CO40	CAD LAB	0	0	2	1
7	ME3CO23	Materials and Material Testing Lab	0	0	2	1
8	ME3CO24	Python Programming for Mechanical Engineers	0	0	2	1
9	EN3ES25	Engineering Materials	3	0	0	3
10	EN3NG02	Universal Human Values & Professional Ethics	2	0	0	2
11	EN3NG10/ EN3NG11/ EN3NG12/ EN3NG13/ EN3NG14	NSS/NCC/Yoga/Sports/Club Activities	0	0	2	1
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3BS15	Engineering Mathematics-III	3	0	0	3

Unit I: Numerical Interpolation techniques:

Difference Operators, Interpolation (Newton Forward and Backward Formulae), Central Interpolation Formulae (Gauss, Bessel's and Sterling's formula), Lagrange's and Divided Difference formulae, Numerical Differentiation.

Unit-IINumerical Differentiation and integration:

Numerical Integration (Simpson's, Weddle's, Trapezodal rules), Numerical Solution of Ordinary Differential Equations (Taylor's Series, Picard's, Euler's Modified, Runge-Kutta, Milne's Predictor and Corrector methods)

Unit III: ProbabilityDistribution:

DiscreteDistribution:Binomial, PoissonDistributionwithmean variance, Moment generating function.

ContinuousDistribution:Normaland Exponential Distribution with mean variance, moment generating function.

Unit IV: Curve fitting,Correlation, Regression:

Curve fitting (Method of Least Square), linear and nonlinear curves,Correlation, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient, Linear Regression, Regression coefficients,Properties of regression curve.

Unit V: Testing of Hypothesis:

Introduction to testing of hypothesis, Statistical assumptions, Level of significance, Confidence level, Type I Error, Type II error, Critical value, Power of the test, sampling distribution, Chi-Square test,small sample test – t test for one and two sample mean, F test, Large Sample test ,Z test for equality of single mean, equality of two sample.

Text Books

1. Higher Engineering Mathematics, B .V. Ramana, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.

2. Probability and Statistics, Ravichandran, Wiley India.

Reference Books

1. Sheldon M. Ross, “Introduction to Probability Models”, Elsevier Publication, Academic Press, UK

2. Numerical Methods for Scientific and Engineering Computation, M .K. Jain, Iyengar and R. K. Jain, New Age International Publication.

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Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3CO18	Manufacturing Processes I	3	0	0	3

UNIT-I MOULDING:

Introduction of moulding, Moulding sand: types, properties and its constituents, testing of moulding sand, Pattern: types allowances, Pattern design, Cores, Core Prints, Core boxes. moulding and core making machines, use of chaplets, CO2 - Process, fluid sand process, shell moulding, cold curing process, hot-box method, high pressure and flask less moulding, Design of metal moulds, Die Design for die Casting.

UNIT II CASTING

Introduction of casting and its types. Solidification of casting, types of gating systems, Pouring time and temperature. Design criteria of pouring basin, screw, runner, gate and riser design, gating ratio, chill and its uses. Selection of melting furnaces, Crucible furnaces, Electric furnaces, Induction furnace. Casting defects, Causes and remedies.

UNIT-III FORGING

Classification of forging processes - forging processes - forging defects and inspection. Rolling: Classification of rolling processes - rolling mill - rolling of bars and shapes.

Extrusion: Classification of extrusion drawing of rods, wires and tubes.

Sheet Metal Working: Sheet metal forming methods: Shearing, Blanking, Bending, Stretch Forming, deep forming. Spinning: Spinning processes. Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes

UNIT-IV WELDING

Welding: Principle, classification, advantages, limitations and applications, Tungsten Inert Gas welding, Metal Inert Gas welding, Electro - slag welding, Electro - Gas Welding, Explosive Welding, Ultrasonic Welding, Electron Bean Welding, Laser Beam Welding, Friction Welding, Cold Welding, Thermit Welding, Codification of Electrodes, Welding Defects-causes and remedies.

UNIT- V POWDER METALLURGY

Definition, advantages, limitations and applications, Powder metallurgy processes and operations, Compaction – Sintering and Finishing – Design considerations for powder metallurgy and Process capability – Shaping of ceramics –Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors.

TEXT BOOKS

1. Rao P.N., "Manufacturing Technology", Vol. 1, Tata McGraw Hill.
2. Sharma P.C., "A Text Book of Production Engineering", Vol.1, S. Chand Publication,NewDelhi.
3. Hajra Choudhry, Elements of Workshop Technology, Vol I & II Media Promoters

REFERENCE BOOKS

1. Production Technology by HMT, Tata Mcgraw Hills
2. Chapman W.A.J, Workshop Technology , Volume II , Oxford and IVH PublishingCompany Ltd
3. Lindberg RA , Processes and Materials of M<anufacture, Prentice Hall Publications

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Course Code	Course Name	Hours per Week			Total	Total
		L	**T**	**P**	**Hrs.**	Credits
ME3CO19	Mechanics of Materials	4	0	0	4	4

UNIT I

Stress and Strain:

Stress, strain and its types, stresses in members of a structure, axial loading, normal stress, shear stress, analysis of simple structures, stepped rods, members in series and parallel: stress strain diagram, Hooke's law, modulus of elasticity, elastic and plastic behaviour of materials, deformation under axial loading ,statically indeterminate problems, stress due to temperature, Poisson's ratio, Bulk modulus, shear strain, relation among elastic constants, residual stress, fibre reinforced composite materials, strain energy under axial loads and stresses due to impact of falling weights.

UNIT II

Principle stress and Strain:

Principle stresses, Principle Planes, Mohr's circle and its application to two- and three-dimensional analysis, stresses in thin-walled pressure vessels, wire winding

UNIT III

Shear force and BM diagram:

Freebody diagrams, Types of support reactions, types of loads , shear force and BM diagram, relationship between load, shear force and bending moment

Shear and Bending Stresses**:** Pure bending, symmetric member, deformation and stress, bending in beams of composite sections, eccentric axial loading, shear stresses in beams, strain energy in bending,

Deflection of beams, equation of elastic curve, Macaulay's method and Area moment method for deflection of beams.

UNIT IV

Torsion in shafts

Torsion Equation , stresses in a circular shaft, deformation in circular shaft, angle of twist, stepped-hollow Shaft, thin walled-hollow transmission shafts. Strain Energy in shafts

UNIT V

Columns and struts : Stability of structures, Euler's formula for columns with different end conditions, Rankin's formula.

TEXT BOOKS

1. Beer FP, Johnson ER, DewolfJT : Mechanics of Materials; TMH
2. Rattan; Strength of materials; TMH
3. Nash William; Schaum's Outline Series; Strength of Materials; TMH.
4. Negi ; strength of materials; TMH

REFERENCE BOOKS:

1. Singh Arbind K; Mechanics of Solids; PHI
2. Sadhu Singh; Strength of Materials; Khanna Pub.
3. Kamal K and Ghai RC; Advanced Mechanics of Materials; Khanna Pub.

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Course Code	Course Name	Hours per Week			Total	Total
		L	T	P	Hrs.	Credits
ME3CO20	Engineering Thermodynamics	4	0	0	4	4

Unit- I

LAWS OF THERMODYNAMICS:

Applications of first law and SFEE in calculation of heat and work in various processes. Applications of second law, calculation of entropy in various processes, performance of thermal machines. Availability, reversibility and irreversibility, Clausius inequality, Carnot's theorem, Third Law

Unit- II

PROPERTIES OF PURE SUBSTANCES :

Phase transformation of water and applications, P-v, T-q, T-v charts, Calorimetry, Use of steam tables and Mollier Chart.

Unit- III

VAPOUR CYCLES :

Vapor Power Cycles, Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle. Reheat & Regenerative cycle, Binary Vapor Cycle.

Unit-IV

BOILERS, STEAM CONDENSERS AND COOLING TOWERS:

Classification of high-pressure boilers, Performance evaluation of boilers; Equivalent evaporation, Boiler efficiency by direct and indirect method Energy balance. Introduction, types of condensers, back pressure and its effect on plant performance air leakage and its effect on performance of condensers, various types of cooling towers, design of cooling towers.

Unit- V

RECIPROCATING AIR COMPRESSORS AND NOZZLES :

Working of reciprocating compressor, work input for single stage compression, effect of clearance, volumetric efficiency, isentropic isothermal and mechanical efficiency, multi stage compression, inter cooling, condition for minimum work input. Types of nozzles, Stagnation and Critical properties, Velocity of sound in perfect gas.

Text Books:

1. P.K.Nag; Engineering Thermodynamics; TMH
2. B K Sarkar;Thermal Engineering; TMH
3. R K Rajput; Thermal Engineering; Laxmi Publicaions

Reference Books:

1. Van GJ; Thermodynamics; Willey Publication
2. Cengel Y; Thermodynamics; TMH
3. Moran & Shapiro; Engineering Thermodynamics, Willey Publication

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Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3CO21	Sensors and Controls	3	0	2	4

Unit-I: Introduction

Description of measuring devices and dynamic characteristics, active and passive sensors and transducers, classifications. Control system components, modeling of a linear dynamic systems, concept of transfer function, open and closed loop systems.

Unit-II: Sensors

Position sensors, velocity sensors, acceleration sensors, force and pressure sensors, light & infrared sensors, proximity sensors, strain gauge, LVDT, RVDT,

Unit-III: Advanced Sensors

Gas sensors and acoustic sensors. automobile sensors (airflow sensor, engine speed sensor, spark knock sensor, coolant sensor, fuel, voltage sensor, camshaft position sensor, throttle position), home appliance sensors (temperature sensors, IR sensors, ultrasonic sensors, hall effect sensor, LDR, UV).

Unit-IV: Feedback systems

Closed loop system components, error detector, digital actuator, block diagram of op-amp, ideal op-amp characteristics, Inverting and non-inverting, Adder, subtracter, integrators and differentiators, comparator,

Unit-V: Sensor based Control

Types of controllers, electrical, pneumatic and hydraulic prime movers and associated control hardware, closed loop control of microcomputer-based drives. Relay control systems and PLC systems and programming, control including sequence control. Sensor based control of various actuators.

Text-Books:

1. D. Patranabis, Sensors and Actuators, PHI.
2. J.Vetelino, A. Reghu, Introduction to Sensors, CRC Press.
3. Ramakant A. Gaikwad, OP- Amp and linear Integrated circuits, Pearson.

Reference Books: -

1. Hermann K.P. Neubert, Instrument Transducers, Oxford University press.
2. R. Sinclair, Sensors and Transducers, Elsevier.
3. B.C. Kuo, Automatic contro systems, PHI.

List of experiments:

1. Displacement measurement using LVDT.
2. Temperature measurement using resistance temperature detector.
3. To perform the characteristics of a Thermistor
4. To perform the characteristics of a Thermocouple
5. Temperature measurement using strain gage.
6. To perform the characteristics of the optical transducers.
7. To perform the characteristics of a DC Tachometer
8. To perform the characteristics of a Proximity sensor for Speed Measurement
9. **To realize inverting and noninverting amplifier using Op-amp.**
10. **To realize adder, subtracter, integrator and differentiator circuits using Op-amp.**

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Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3CO23	MATERIALS AND MATERIAL TESTING LAB	0	0	2	1

List of Experiment

Experiments

1. Preparation of specimen for Metallographic examination of different engineering materials for analysis of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & Composites.
2. Study of determination of structures of simple crystals by x-ray diffraction. and microscope.
3. Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens.
4. Tensile and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine.
5. To conduct Shear test on Mild steel and Cast Iron using Universal Testing Machine.
6. Bending Test on steel and wood specimens.
7. Izod and Charpy Tests on Mild steel and C.I Specimen
8. Impact test by falling dart method on PVC pipe.
9. To study the wear and fracture characteristics of ferrous and non-ferrous materials under different parameters.
10. Fatigue Test (demonstration only).

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Course Code	Course Name	Hours per Week			Total	Total
		L	**T**	**P**	**Hrs.**	Credits
EN3ES25	Engineering Material	3	0	0	3	3

UNIT I: STRUCTURES:

Atomic structure and bonding in materials. Crystal structure of materials, crystal systems, unit cells and space lattices, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Imperfections in crystalline solids and their effect various properties.

UNIT II MATERIAL BEHAVIOR &MECHANICAL PROPERTIES:

Elasticity in metals, mechanism of plastic deformation, strengthening mechanisms, stress-strain diagrams of metallic, ceramic and polymeric materials. Ductile to brittle transition, creep failure mechanism, fatigue mechanism. Mechanical properties of material.

UNIT III PHASE DIAGRAMS & HEAT TREATMENT:

Introduction - Solid solutions,Hume-Rothery rules for solid solutions, Phase rules , Phase diagrams - Binary phase diagrams - tie line and lever rule; Iron-Iron carbide metastable diagram, development of micro-structures in iron-carbon alloys. Isothermal transformation diagrams, TTT curves, various heat treatment processes.

UNIT IV METALLIC MATERIALS:

Stainless and tool steels, HSLA, Maraging steels, TRIP steel – Cast Irons, Properties and applications of - Cu and its alloys, Al and its alloys, Age hardening, Ti and its alloys, Ni-based alloys- super alloys.

UNIT V NON METALLIC MATERIALS:

Introduction, properties Types and applications of Polymers , Composites and its types , and Ceramics - advanced structure ceramics, Shape memory alloy, Nano-materials - its important properties at nanoscale and applications-carbon nano-tubes.

TEXT BOOKS:

1. Raghavan V; Material Science and Engineering, PHI Publication.
2. W.D. Callister, Jr., Materials Science and Engineering: An Introduction, Wiley & Sons
3. Krishnan K. Chawla, Composite materials, Science and Engineering Springer.

REFERENCE BOOKS:

1. J.C. Anderson, K.D. Leaver, P. Leavers and R.D. Rawlings, (2003), Materials Science for Engineers, 5th edition, Tata McGraw Hill Publishers.
2. William F. Smith and Javad Hashemi (2004), Foundations of Materials Science and Engineering 4th ed., Mc Graw Hill.
3. Sidney H Avner, (2005) “Introduction to Physical Metallurgy, Tata McGraw Hill Publishing Company Limited.
4. Lawrence E.Murr (2000), Failure analysis, Marcel Dekker Inc. Publications.
5. Askeland; The science and engineering of material, Cengage learning.

Course Code	Course Name	Hours per Week			Total	Total
		L	T	P	Hrs.	Credits
EN3ES24	Python Programming	0	0	2	2	1

Unit-I Introduction :

Introduction to Python and its history, how python is different from other programming languages and similarities. Application and uses. Python Installation, Installing the Anaconda, Python IDE, Toolbars, working area, sub menus, working modes.

Unit-II Basic constructs of Python :.

Variables in python Input and Output in Python, Basic commands. Tokens Basic program structure-quotation and indentation, Operator, Basic data types and In-built objects.. Basics Expressions, Assignment Statement, Arithmetic Operators, Operator Precedence, Boolean Expression.

Unit-III Conditional Statement and Looping in python :

If-else , for loop, while loop, break, pass, continue, creating Functions, functions with arguments, returning values from functions, lambda expressions, recursion, global and local variables, Importing other modules/packages and using their functions.

Unit-IV Object Oriented Programming in Python:

Class and Object. Defining variables and functions inside class. Creating objects, Inheritance, Multiple and Multi Level Inheritance, Function overriding, the concept of composing objects of a different class in an object, problems on object composition. Encapsulation, Polymorphism, Constructors.

Unit-V Libraries in Python : Use of libraries in python like Numpy , Panda etc., Arrays, Matrices in python. Matplotlib library for plotting the data, Figures and axes Subplots, Grid Spaces, Contour Plots, Surface Plots, Polar Plots and Seaborn.

Text Book:

1. Dr.R.Nageswara Rao, Core Python Programming, dreamtech press.
2. Paul Barry, Head First Python, O'REILLY.

Reference Book:

1. Mark Luiz, Learning Python, O'REILLY.

2. Jamie Chan, Learn Python in One Day, LCF Publishing.

List of Experiments

1. Write a program to print hello user on the output screen.
2. Write a program using various operators.
3. Write a program to perform arithmetic operations on two numbers.
4. Write a program stating which number is greater using conditional statements.
5. Write a program to check weather a number is even or odd
6. Write a program by the use of for loop and nested for loop.
7. Print the table of 2 using a while loop.
8. Write a program to reverse an integer.
9. Write a program to determine whether a number is palindrome or not.
10. Write a program using strings and extract the individual character.
11. Write a program using various functions of strings in it.
12. Write a program using tuples and perform various functions of tuples in it.
13. Write a program using list and perform various functions of list in it.
14. Prepare a program for dictionary consisting of various key element and perform various operations in it.
15. Write a program using normal function and lambda function.
16. Write a program with Class name Phone and add the various parameter of class.
17. Write a class program using a constructor.
18. Write a program using inheritance.
19. Write a program using Numpy to demonstrate array creation techniques.
20. Write a program on football data using Numpy , Panda and Seaborn libraries.

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Medi-Caps University, Indore

Course Code	Course Name	Hours per Week			Total	Total
		L	T	P	Hrs.	Credits
ME3CO24	Python for Mechanical Engineering	0	0	2	2	1

Unit-I Introduction :

Introduction to Python difference and similarity from other programming languages ,Python Installation, Installing the Anaconda, Python IDE, Toolbars, working area, sub menus, working modes.Variables in python Input and Output in Python, Basic commands.

Unit-II Basic constructs with Conditional Statement and Looping in Python :.

Tokens Basic program structure-quotation and indentation, Operator, Basic data types and In-built objects.. Basics Expressions, Assignment Statement, Arithmetic Operators, Operator Precedence, Boolean Expression.If-else , for loop, while loop, break, pass, continue, creating Functions, functions with arguments, returning values from functions, lambda expressions, recursion, global and local variables, Importing other modules/packages and using their functions

Unit-III : Object Oriented Programming in Python:

Class and Object. Defining variables and functions inside class. Creating objects, Inheritance, Multiple and MultiLevel Inheritance, Function overriding, the concept of composing objects of a different class in an object, problems on object composition. Encapsulation, Polymorphism, Constructors

Unit-IV Libraries in Python : Use of libraries in python like Numpy , Panda etc., Arrays, Matrices in python. Matplotlib library for plotting the data, Figures and axes Subplots, Grid Spaces, Contour Plots, Surface Plots, Polar Plots and Seaborn.

Unit-V Application of python in mechanical engineering problems

Problem based on shear force and bending moment, problem based on efficiency of ic engine, pv graph plotting, analysis of various fluid mechanical properties, tolerance measurement.

Text Book:

1. Dr.R.Nageswara Rao, Core Python Programming, dreamtech press.
2. Paul Barry, Head First Python, O'REILLY.
3. James Payne, "Beginning Python: Using Python 2.6 and Python 3.1", Wrox Publication
4.Magnus Lie Hetland, "Beginning Python from Novice to Professional", Second Edition", Apress Publication.

Reference Book:

1. Mark Luiz, Learning Python, O'REILLY.
2. Jamie Chan, Learn Python in One Day, LCF Publishing.
3.Wesley J Chun, "Core Python Applications Programming", Third Edition, Pearson Publication.
4. E. Balaguruswamy," Introduction to Computing and Problem Solving using Python" McGraw Hill Education IndiaPvt., Ltd.

Web Resources:

1, https://www.edx.org/course/introduction-to-python-absolute-beginner-3.

2, https://onlinecourses.nptel.ac.in/noc19_cs40.

List of Experiments

1. Write a program to print hello user on the output screen.
2. Write a program using various operators.
3. Write a program to perform arithmetic operations on two numbers.
4. Write a program stating which number is greater using conditional statements.
5. Write a program to check weather a number is even or odd
6. Write a program by the use of for loop and nested for loop.
7. Print the table of 2 using a while loop.
8. Write a program to reverse an integer.

9. Write a program to determine whether a number is palindrome or not.
10. Write a program using strings and extract the individual character.
11. Write a program using various functions of strings in it.
12. Write a program using tuples and perform various functions of tuples in it.
13. Write a program using list and perform various functions of list in it.
14. Write a program using normal function and lambda function.
15. Write a program with Class name Phone and add the various parameter of class.
16. Write a program using inheritance.
17. Formulate a plan for the delivery of two sets of important products A and B. Each box of Product A weighs 20 kg and occupies 0.45m^3. Each box of Product B weighs 30 kg and occupies 0.35m^3. The profit for transporting Product A is $ 4.10. The profit for transporting Product B is $ 5.40. The truck has the capacity to transport 2 tons and the space of 30m^3. Knowing that the carrier wants to transport as many products as possible and obtain the highest possible profit, use linear programming, and solve the problem using python.
18. Calculate the efficiency of otto cycle and plot its pv diagram using following data : Initial pressure and temperature are 1atm and 500K respectively. Maximum temperature is 2300k, gamma is 1.4, bore 100cm, stroke length 100cm,
19. Would a tank of radius = 5 m, and height = 10 m be overfilled if the flow rate of water is 15 cubic m/min within two hours? Do the analysis using python.
20. Write a program for analysis of SF and BM on a simply supported beam carrying udl of 500N/m for a span of 5m at a distance of 2.5m from the left support. The total length of the beam is 10m.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3CO40	CAD LAB	0	0	2	1

Course Learning Objectives (CLOs):

CLO-01: To understand the AutoCAD workspace and user interface

CLO-02: To understand the use of basic drawing command and editing command

CLO-03: To understand the difference between 2D Drafting, Isometric drafting and 3D modeling

CLO-04: To get familiar with use of tools used to make 2D Drafting, Isometric Drafting

CLO-05: To get familiar with use of tools used to make 3D Geometry

Part-A: Introduction to Machine Drawing

- Conventional representation of Machine Components
- Sectional views of Machine Components
- Dimensioning of Machine Components
- Surface finish, GD & T symbols

Part-B: Application of Computer Aided Drafting

- Getting familiar with Drafting
- Draw Toolbar
- Hatching & Gradient
- Modify Toolbar, Array Tool
- Status Bar toggle keys
- Object Properties, Important drawing Tools
- Dimension Toolbar
- Isometric Drafting
- Creating Multileader, Geometric Drawing & Tolerances, Text, Table
- Blocks & Groups
- Managing Drawing with layers
- Parametric Drawing

- External References, Layout Printing & Plotting

Part-C: Introduction to the 3D Modeling Workspace

- Basic 3D Viewing Tools
- 3D Navigation Tools
- Introduction to the User Coordinate System (UCS)
- Working with Solid Primitives, Solid Primitive Types
- Working with the User Coordinate System
- Complex 3D Geometry
- Extruded Solids and Surfaces
- Swept Solids and Surfaces
- Revolved Solids and Surfaces, Lofted Solids and Surfaces, NURBS Surfaces
- 3D Gizmo Tools, Aligning Objects in 3D Space
- 3D Modify Commands, Editing Components of Solids, Editing Faces of Solids
- Fillets and Chamfers, Creating a Shell
- Imprinting Edges of Solids, Slicing a Solid along a Plane
- Converting Objects to Surfaces, Converting Objects to Solids,

Part-D: Refining the View

- Working with Sections, Working with Cameras, Managing Views in 3D
- Creating Visual Styles, Working with Materials Specifying Light Sources
- Rendering Concepts, Working Drawings from 3D Models
- Creating Multiple Viewports, 2D Views from 3D Solids.

Part-E: Drawing Practice: 2D & 3D

Individual Projects:

1. Shift Lever
2. Form Roll Leaver
3. Nut, bolt & washer assembly
4. Knuckle Joint Assembly
5. Cotter Joint

6. Universal Joint
7. Solid muff coupling
8. Bush Type Coupling
9. Crosshead
10. Cam shaft
11. Connecting rod
12. Piston
13. Piston and connecting rod
14. Plumber block
15. Bush Bearing
16. Journal Bearing

Text Books:

1. AutoCAD 2021 For Beginners. By Cadfolks, Kishore Publication
2. A Hand Book On Autocad Tools Practice by Azhar Wahab, Notion Press publication
3. Mastering AutoCAD 2019 and AutoCAD LT 2019 By Brian C. Benton and George Omura, Sybex publication
4. Discovering AutoCAD 2020 By Mark Dix, Macromedia Press
5. Autocad Mechanical Exercise Book, by CAD Desk, CAD Desk Publication

Reference Books:

1. AutoCAD 2020 A Project-Based Tutorial By Tutorial books, Independently published
2. AutoCAD Exercises for Beginners: Designers WorkBook for Practice ByShameer S.A., Independently Published
3. Beginning AutoCAD 2022 Exercise Workbook, by Cheryl R. Shrock, Steve Heather, Industrial Press
4. 3D Modelling Mechanical Exercise Book, by CAD Desk, CAD Desk Publication

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO01: Understand CAD, its Importance and Application

CO02: Understand the workspace and user interface of CAD Software

CO03: Understand the application of different Drawing Command Editing Command for 2D Drafting, Isometric Drafting and 3D modeling

CO04: Analyze Industrial Drawing of Various product

CO05: Create solid 3D model using any CAD software

SEMESTER – IV

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3CO45	Manufacturing Processes- II	4	0	2	5
2	ME3CO46	Fluid Mechanics and Machinery	4	0	2	5
3	ME3CO47	Kinematics of Machines	4	0	2	5
4	EN3HS04	Fundamentals of Management, Economics & Accountancy	3	0	0	3
5	ME3CO30	Industrial Engineering & Operations Research	3	0	0	3
6	ME3ELXX	Program Elective - I	3	0	0	3
7	EN3NG10	Soft Skills -II	2	0	0	2
		Total	**23**	**0**	**6**	**26**
		Total Contact Hours	**29**			

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO45	Manufacturing Processes- II	4	0	2	5

COURSE LEARNING OBJECTIVES (CLO's):

- **CLO 01** To understand the basic knowledge of basic machine elements used in a machine shop.
- **CLO 02** To understand the sequence of operation for manufacturing of any product by machining.
- **CLO 03** To understand the geometry of a single point cutting tool.
- **CLO 04** To understand the basic mechanics, operation, and application of various machines such as Lathe, Shaper, Drilling, Grinding, Broaching etc.
- **CLO 05** To understand the basic knowledge of non-traditional machining

UNIT I MECHANICS OF METAL CUTTING:
Fundamentals of machining, Machinability, mechanics of metal cutting, orthogonal vs oblique cutting, mechanics of chip formations, types of chips, tools geometry, Merchant's force circle diagram, cutting forces, power required, shear zone, chip thickness measurement, strain rates, tool signature and nomenclature, tool life and wear, speed, feed, depth of cut, machining time.

UNIT II LATHE, SHAPERS & PLANER MACHINE:
Lathe Machine: Introduction, type, specification, components & accessories for various operations on lathes, taper turning methods, methods of thread production, capstan & turret lathes.
Shapers and Planer Machine: Introduction, operations, specifications, parts, quick returns mechanism.

UNIT III MILLING, DRILLING, BROACHING MACHINE & WORK HOLDING:
Milling: Introduction, classifications and specifications of milling machines, milling cutter, up & down milling, determination of maximum chip thickness, power required.
Drilling: Introduction, calculation of drilling time, working principle of radial and universal drilling machines.
Broaching: Principle, Types of broaches and broaching machines.
Work holding device: Introduction & working principle of jigs and fixtures.

UNIT IV ABRASIVE MACHINING PROCESSES:
Grinding : Specification and selection, wheel turning and dressing, types of grinding processes- surface grinding, cylindrical grinding, centre-less grinding, internal grinding- honing, lapping, supper finishing.

UNIT V CNC AND NON-TRADITIONAL MACHINING PROCESSES:

Introduction to NC/CNC machines: offset setting, G-code, M-code, and CNC part programming.
Non-traditional Machining Processes: Introduction, working principle, process characteristics & applications of - Electrical discharge machining (EDM), Electro chemical machining (ECM) Abrasive jet machining (AJM), Water jet machining (WJM), Ultrasonic machining (UJM), Electron beam machining (EBM), Laser beam machining (LBM).

TEXTBOOKS:

1. S. Kapakjian and S.R. Schmid, (2010), Manufacturing Engineering and Technology, 6th Edition, Pearson Education (Singapore) Pvt. Ltd.
2. P. N. Rao, (2009), Manufacturing Technology, Vol. 2, 2nd ed., Tata McGraw Hill Publications.
3. P.C. Sharma, (2000), Text book of Production Technology, S.Chand & Company Ltd, New Delhi.

REFERENCE BOOKS:

1. Lindberg RA; Processes and Materials of Manufacturing; PHI.
2. Raghuvanshi;BS; Work shop technology Vol-I, II; Dhanpat Rai Delhi
3. Alciatori DG, Histand MB; Introduction to Mechatronics and Measurement system; TMH

Course Outcomes (CO's):
After completion of this course the students shall be able to:

CO 01	Understand all types of traditional machines, its working principle, operation and uses
CO 02	Identify types of chips, mechanics of machines, tool geometry, and tool material.
CO 03	Develop understanding of various accessories used in machines.
CO 04	Understand different methods of finishing.
CO 05	Understand concept of non-traditional machining.

LIST OF PRACTICAL:

1. To perform various operations on the lathe machine tool according to given drawing.
2. To perform various shaping operations to cut a groove on mild steel specimens according to the given specification.
3. To perform plane milling operation on the given specimen (mild steel) for spur gear cutting.
4. To make a job on a radial drilling machine.
5. To perform a finishing operation on a surface grinder.
6. To make a job on a CNC turning and milling machine according to the given specification.
7. Industrial visit for the students on metal forming processes.
8. Industrial visit for the students on metal casting processes.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO46	Fluid Mechanics and Machinery	4	0	2	5

COURSE LEARNING OBJECTIVES (CLO)

CLO_{01} To give the knowledge of fluid, types, properties, how to measure pressure, associated laws of pressure, understanding of the buoyancy, principle of floatation, floating and submerged bodies

CLO_{02} To understand fluid kinematics terminology such as streamline, path line, streak line, velocity potential function, stream function, concept of flow net, basic knowledge about Euler's theorem, Navier-Stokes equation, forces on vanes, losses in pipes etc.

CLO_{03} To understand working of hydraulic turbines, efficiencies related to turbines, calculation related to power and efficiency, draft tube.

CLO_{04} To understand working of hydraulic pumps, efficiencies and heads related to pumps, calculation related to power and efficiency, cavitation and priming.

CLO_{05} To understand the dimensional homogeneity and various theorems for dimensional analysis, dimensionless numbers and similarity laws

UNIT I: FLUID PROPERTIES AND HYDROSTATICS

Introduction, Fluid Properties- mass density, weight density, viscosity, specific gravity, specific volume, Newton's law of viscosity, Hydrostatic forces on plane – inclined surfaces only – buoyancy – centre of buoyancy – metacentre.

UNIT II: KINEMATICS AND DYNAMICS OF FLOW

KINEMATICS: Types of flow-ideal & real, steady & unsteady, uniform & non uniform, one, two, and three-dimensional flow, path lines, streak-lines, streamlines; continuity equation for one- and three-dimensional flow, rotational & irrotational flow, velocity potential, stream function.

DYNAMICS: Euler's equation of motion along a streamline and derivation of Bernoulli's equation, application of Bernoulli's equation, linear momentum equation for steady flow. The moment of momentum equation, forces on fixed and moving vans. Head Losses in pipes

UNIT III: HYDRAULIC TURBINES

Hydraulic Turbines, classification, Hydraulic, volumetric, mechanical and overall efficiencies, Pelton and Francis Turbines, their velocity triangles, calculation of power and efficiency, draft tube and its applications.

UNIT IV: HYDRAULIC PUMPS

Centrifugal pumps, classification, advantage over reciprocating type, definition of manometric head, gross head, static head, vector diagram and work done. Main and operating characteristics of the machines, cavitations, priming of pumps.

UNIT V: DIMENSIONAL ANALYSIS

Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers, similarity laws.

TEXT BOOKS:

1. M. M. Rathore, Thermal Engineering, TMH
2. R.K. Bansal, Fluid Mechanics & Fluid Machines, Lakshmi Pub.
3. Congel; Fluid Mechanics; TMH

REFERENCE BOOKS:

1. B.K. Venkanna, Turbomachinery, PHI
2. K.L. Kumar, Fluid Mechanics, S. Chand Pub.
3. White; Fluid Mechanics; TMH

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01} Explain the properties of fluids, fundamentals of fluid mechanics; pressure exerted by fluids and measurement of pressure, Forces on submerged bodies.

CO_{02} Explain different types of fluid flows, different methods applied for describing fluid in motion and different types of energies associated with Fluid in motion.

CO_{03} Explain the working of hydraulic turbines, efficiencies related to turbines, calculation of power and efficiency and concept of draft tube.

CO_{04} Explain the working of hydraulic pumps, various efficiencies and heads associated to pumps, calculation related to power and efficiency, concept of cavitation and priming.

CO_{05} Explain the concept of dimensional homogeneity and various theorems for dimensional analysis, dimensionless numbers and similarity laws.

LIST OF EXPERIMENT:

1. To Verify Bernoulli's Theorem.
2. Determination of meta-centric height
3. Calibration of Orifice meter and Venturi meter and Rotameter.
4. To determine the local point pressure with the help of pitot tube
5. Determination of Friction Factor of a pipe (Major Losses)and fittings (Minor Losses).
6. Reynolds experiment for demonstration of streamline or turbulent flow
7. Verification of Impulse momentum principle.
8. To conducts an experiment on Pelton turbine test rig.
9. To conducts an experiment on Francis's turbine test rig.
10. To study the effect of a draft tube on reaction turbines.
11. To conduct a test on Centrifugal Pump and plot its characteristics.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO47	KINEMATICS OF MACHINES	4	0	2	5

COURSE LEARNING OBJECTIVES (CLO's):

CLO 01 To understand basic concepts and kinematic aspects of different mechanisms using the concept of Inversion used in machines. Its helps to understand the types of links required to develop a mechanism based on given degree of freedom using number synthesis.

CLO 02 To understand the concept of velocity and acceleration of different points of a links in a mechanism.

CLO 03 To understand the basic concepts of cam -follower mechanism and able to design cam profiles for given follower motions and analysis for cams with specific contour.

CLO 04 To understand the basic concept of gears and understand the various types of gear trains.

CLO 05 To understand the basic concepts of gyroscope couple and its effect on aeroplane, two- wheeler and four -wheeler, and naval ship.

UNIT I: MECHANISMS AND MACHINES

Rigid and resistant body, Definitions and classification of Kinematic Links, Kinematic pairs, Chains, Mechanism and machine., Degrees of freedom: Kinematic pairs and mechanism, Gruebler's&Kutzback's Criterion for planer mechanisms, Kinematic inversion, Different Inversions of Four bar chain, Single Slider and Double slider-crank chain. Davi's and Ackermann Steering Mechanisms, Pantograph Mechanisms, Quick Return Mechanisms- Slotted Lever and Whitworth's type.

UNIT II: VELOCITY AND ACCELERATION ANALYSIS IN MECHANISMS

Displacement of a rigid body -Combination of rotation and translation, Relative displacement of two points on a rigid body, Pure rotation of a rigid body- Angular velocity of link , Kinematic Analysis of Mechanisms :Graphical Methods of Velocity Analysis of Planer Mechanisms: Relative Velocity Method up to four links, Instantaneous Centre of Rotation Method:Properties of instantaneous centers, Aronhold- Kennedy Theorem of three centers, Velocity determination in simple four bar and slider crank mechanisms, Acceleration Analysis of Planer Mechanisms: Klein's Construction for velocity and acceleration of Slider Crank mechanism.

UNIT III: CAMS AND FOLLOWERS

Classification of Cams and Followers, Terminologies of Cams, Displacement, velocity, and accelerations of followers for standard motions – Uniform motion, Parabolic, SHM and Cycloidal. Cam profile generation.

UNIT IV: GEARS AND GEAR TRAINS

Classification of gears, Law of gearing, Spur Gears : Terminology, Velocity of sliding, Tooth profiles- Cycloidal and Involute and their comparison, Concept of path of contact, arc of contact and contact ratio and their relationship for spur gear pair, Concepts of Interference and Undercutting, Minimum number of teeth to avoid interference between. Gear Trains: Spur Geared trains: Simple, Compound, Reverted and Epi-Cyclic - Velocity ratio.

UNIT V: GYROSCOPE

Concepts of Gyro-couple and Gyro-reaction Couples. Evaluation of gyroscopic couple. Evaluation of gyro-reaction couples and their effects in different machines – Boat, Aeroplane, Two wheeler and Four wheeler, Stabilization of naval ship using Gyroscopic effect.

TEXT BOOKS

1. Rattan S.S.; Theory of machines; Mc-Graw Hills Publications.
2. Ambekar A. G.; Mechanism and Machine Theory; PHI. Eastern Economy Edition.
3. Khurmi R. S. and Gupta J. K., Theory of Machines, S. Chand & Co.

REFERENCE BOOKS

1. Bevan T., "Theory of Machines: A text book for engineering students", CBS, New Delhi.
2. Jagdish Lal; Theory of Machines; Metropolitan Book Co; Delhi
3. Ghosh, A, and Malik, A. K. "Theory of Mechanisms and Machines", East West Press Pvt. Ltd.

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

- **CO 01** Select the appropriate mechanism used in machine.
- **CO 02** Analyse velocity and acceleration of mechanism/machine by graphical and analytical method.
- **CO 03** Decide appropriate cam follower mechanism to achieve desired motion in different applications.
- **CO 04** Select Suitable gear mechanism for power transmission.
- **CO 05** Apply concepts of gyroscopic couple in automobile, aeroplane and naval ship.

LIST OF PRACTICALS

1. To determine the degree of freedom of different kinematic pairs
2. To verify the principle of Pantograph apparatus.
3. To verify the principle of Watt's and Peaucellier's Straight line mechanisms.
4. To determine the cutting ratios in Whitworth and SlottedLever Quick Return Mechanisms
5. To verify the torques due to Coriolis component of acceleration.
6. To draw the cam profile of a given cam.
7. To identify different types of gears and their nomenclature on tooth profile.
8. To verify the velocity ratio and the holding torque in an epi-cyclic gear train.
9. To verify the applied gyroscopic couple using motorized gyroscopic apparatus.
10. To determine slip and creep and power loss in flat belt drive.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
EN3HS04	Fundamentals of Management, Economics & Accountancy	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO_{01} To introduce the Fundamental knowledge of Management.
CLO_{02} To give knowledge about the Marketing and Human Resource Management.
CLO_{03} To provide basic information of Applied Economics.
CLO_{04} To get acquainted with the knowledge of Financial Accounting.
CLO_{05} To give sufficient knowledge of Financial Management.

UNIT I: CONCEPTS OF MANAGEMENT

Definition, characteristics and importance of management; Management: Science or Art, Difference between Management and Administration, Levels of management, Functions of Management, Managerial Roles, Managerial skills and competencies; Decision Making: Definition, process and types; Decision making under certainty, uncertainty and risk; Cross cultural issues in management and challenges.

UNIT II: FUNDAMENTALS OF MARKETING AND HUMAN RESOURCE MANAGEMENT

Introduction to Marketing: Definition, importance, function and scope of marketing, Core concepts of marketing, Marketing concepts and orientations, Marketing environment, Marketing-mix, Holistic marketing concept, Customer Relationship Management (CRM).Introduction to Human Resource Management (HRM): Nature, Scope, Objectives and Functions; Role of HR manager, Process and need for Human Resource Planning, Human resource policies, Changing role of Human Resource in India, Globalization and its impact on Human Resource.

UNIT III: FUNDAMENTALS OF ECONOMICS

Definition, nature, scope and significance; Difference between micro and macro economics; Time value of money, Law of diminishing marginal utility; Theory of Demand and Supply, Price elasticity of demand; Meaning and types of costs, Law of variable proportions; Types of market structure; National income and related aggregates; Meaning and types of Inflation; Meaning and phases of business cycle.

UNIT IV: BASIC ACCOUNTING PRINCIPLES

Accounting Principles and Procedure, Double entry system, Journal, Ledger, Trial Balance, Cash Book; Preparation of Trading, Profit and Loss Account; Balance sheet; Cost

Accounting: Introduction, Classification of costs, Methods and Techniques of costing, Cost sheet and preparation of cost sheet; Break Even Analysis: Meaning and its application.

UNIT V: FUNDAMENTALS OF FINANCIAL MANAGEMENT

Introduction of Business Finance: Meaning, Definition of Financial Management, Goals of Financial Management (Profit Maximization and Wealth Maximization), Modern approaches to Financial Management — (Investment Decision, Financing Decision and Dividend Policy Decisions).

TEXT BOOKS:

1. R. D. Agarwal, Organization and Management, McGraw Hill Education.
2. P. C. Tripathy and P. N. Reddy, Fundamentals of Management, Economics and Accountancy Tata McGraw Hill
3. Kotler Philip and Keller Kevin Lane, marketing Management Pearson

REFERENCE BOOKS:

1. Peter F Drucker, The Practice of ManagementMcGraw Hill
2. Harold Koontz, Essentials for Management, Tata McGraw Hill
3. M Y Khan and P K Jain, Management Accounting Tata McGraw Hill

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01}	Understand Basics of Management Theory.
CO_{02}	Gaining knowledge of Marketing & Human Resource Management.
CO_{03}	Understand basic information for Economics.
CO_{04}	Get acquainted with the Financial Accounting System
CO_{05}	Gain sufficient knowledge of Financial Management

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO30	Industrial Engineering & Operation Research	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

- **CLO_{01}** To develop concepts related to principles of productivity & work study.
- **CLO_{02}** To apply the concepts related to operational analysis & measuring work for designing the work systems.
- **CLO_{03}** Review the emerging concepts and principles in work system design for productivity improvement.
- **CLO_{04}** Develop the skills in the application of operations research models for complex decision making situations.
- **CLO_{05}** To Implement the methodology and tools of operations research to assist decision -making.

UNIT I: INTRODUCTION TO WORK STUDY

The basic procedure of work-study. Work study for establishing the standard time for a given activity. Method study, procedure for Method study, Principles of motion economy, Filming techniques and micro motion analysis, recording technique. Construction of process chart, Gantt chart, SIMO chart, string chart, Travel chart, Multiple activity chart, Sampling process, Critical examination analysis. Primary, secondary and tertiary stages, Search for alternatives. Steps involved in evaluation of alternatives

UNIT II: INTRODUCTION TO WORK MEASUREMENT

Introduction to work measurement, objectives of work measurement, Techniques of work measurement. Basic procedure in time study, Advantages and limitations of time study, Time recording techniques in time study. Performance rating standard allowances, personal allowance, fatigue allowance, production delay allowance, Factors affecting the rating, Synthetic rating method

UNIT III: INTRODUCTION TO OPERATIONS RESEARCH

Basics definition, scope, objectives, phases, models and limitations of Operations Research.Introduction to Linear Programming, Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, Big-M method, two-phase method, degeneracy and unbound solutions.

UNIT IV: TRANSPORTATION PROBLEM, ASSIGNMENT PROBLEM

Mathematical model, Balanced and unbalanced problems, Degeneracy, Optimality conditions, Methods to find starting solution and optimal solution. Assignment problem: Mathematical model, Balanced and unbalanced problems, Optimality conditions, Hungarian method. Two-person zero-sum games: Saddle points, Mixed strategies, Fundamental theorem, Computational methods using graphs and linear programming, Introduction to nonzero sum game.

UNIT V :QUEUING THEORY, GAME THEORY

Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:∞/FCFAGame Theory: Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.

TEXT BOOKS:

1. Operations Research: An Introduction by Hamdy Taha, Pearson.
2. Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd.
3. Introduction to work study by ILO, 4th revised edition

REFERENCE BOOKS:

1. Operations Research by A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education
2. Operations Research by P Mariappan, Pearson.
3. Operations Research by H N Wagner, Prentice hall.
4. Optimization in Operations Research by Ronald L. Rardin, Pearson Education Inc

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01}	Apply selected industrial engineering techniques for enhancing productivity in an organization.
CO_{02}	To manage projects & improve the performance of routine activities by application of appropriate industrial engineering tools.
CO_{03}	To understand the basic concepts of different models of operations research and their applications.
CO_{04}	To apply the models to incorporate rational decision making process in real life situations.
CO_{05}	To analyze various modeling alternatives & select appropriate modeling techniques for a given situation

PROGRAM ELECTIVE-I

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL05	Finite Element Method	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO)

CLO_{01} Students should identify and compare the outputs of different methods to solve the governing equation of a process.

CLO_{02} Students must understand the different terminologies and features of finite element methods.

CLO_{03} Students must understand when to distinguish a given domain as one dimensional problem and implement structural concepts.

CLO_{04} Students must understand when to distinguish a given domain as two dimensional problem and implement structural concepts.

CLO_{05} Students must understand the applications of Finite Element Method to different domains

UNIT I: INTRODUCTION

Mathematical Formulation of Engineering Problems, Types of Governing equations- Differential formulation, Energy –Integral formulation, Solution Methodologies-Analytical, Physical and Computational, Overview of approximate methods for the solution of the mathematical models- Rayleigh-Ritz method , Methods of Weighted Residuals (Galerkin, Least-squares & Collocation methods), Variation method, Finite Element Method- General description of Finite Element Method, History and Working of FEM Applications of FEM, Advantages and Limitations of FEM, FEA softwares.

UNIT II : FINITE ELEMENT MODELING

General procedure of FEM, Idealization- Mathematical Models, Implicit vs Explicit Models Various approaches in FEM- Direct Approach, Variational Approach, Energy Approach and Weighted Residual Approach, Discretization, Classification of Elements, Concept of Degree of Freedom, Boundary Conditions, Shape Function- Derivation of shape functions for various elements, Formulation of Finite element characteristic matrices and vectors, Compatibility conditions, Assembly and boundary considerations, Concept of Shape Functions.

UNIT III: STRUCTURAL ANALYSIS OF ONE-DIMENSIONAL PROBLEMS

Equilibrium of a cubical element subjected to three dimensional stresses-Concept of body and surface forces, Stress Strain relationship in three dimensional stresses, Plane Stresses and Strain.

Bar Element : Linear and Quadratic elements, Elemental stiffness matrix, Properties of global stiffness matrix; FE formulation using Potential Energy Approach, Element numbering and connectivity concept, half band width, structural and thermal strains, calculation of shape functions, elemental load vectors and stiffness matrices treatment for various boundary conditions- elimination and penalty approach.

UNIT IV: STRUCTURAL ANALYSIS OF TWO-DIMENSIONAL PROBLEMS

Plane stress and strain, Modeling using constant strain triangle (CST) element, Shape functions for CST, concept of Jacobian, calculation of stiffness matrices and load vectors using potential energy approach, Modeling using linear quad element, Shape function, Iso-parametric representation, Jacobian matrix, strain-displacement matrix, stress-strain relationship matrix, force vector, Axi-symmetric Solids subjected to axi-symmetric loading : Axi-symmetric formulation in cylindrical coordinates , Finite Element modeling, using triangular elements, shape functions, concept of stress-displacement relations and jacobian, element stiffness matrix, body and traction force vectors, temperature load vector.

UNIT V: FEA IN OTHER DOMAINS

Finite Element formulation of One- dimensional steady state Heat conduction and Convection, Hemholz equation, Concept of conductivity matrix, Heat Load Matrix, Finite Element formulation of invisicid and incompressible flow Potential function formulation, Stream function formulation. FEA in dynamic problems- single degree of freedom vibrating systems. Formulation, consistent and lumped mass matrices for 1-D and 2-D element, Solution of Eigen-value 1-D problems.

TEXT BOOKS:

1. T. R. Chandrupatla and A. D. Belugundu, Introdution to Finite Elements in Engineering, Prentice Hall.
2. ChennakesavaR.Alavala, Finite Element Method, Prentice Hall.
3. Y.M.Desai, T.I.Eldho, A.H.Shah, Finite Element Method, Pearson

REFERENCE BOOKS:

1. G Laxmi Narasaiah, Finite Element Analysis, B.S.Publications
2. U.S.Dixit, Finite Element Methods for Engineers, Cengage Learning
3. S.S.Rao, The Finite Element Method in Engineering, Butterworth-Heinemann Elsevier

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO 01	Students will be able to implement the different mathematical approaches to formulate and solve a given problem other than the finite element method.
CO 02	Students will be able to design a given problem from the point of view of Finite Element Method.
CO 03	Students will be able to formulate and implement structural analysis to a one dimensional domain using Finite Element Modelling.
CO 04	Students will be able to formulate and implement structural analysis to a two dimensional domain using Finite Element Modelling.
CO 05	Students will be able to formulate and apply the Finite Element Modelling to problems of other domains like- Heat transfer, Fluid flow and problems of dynamic nature.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL11	Hydraulic and Pneumatic Control	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO)

- **CLO_{01}** Define the basic principles of hydraulics and pneumatics.
- **CLO_{02}** Identify and describe the various components used in hydraulic and pneumatic systems.
- **CLO_{03}** Understand the process of designing hydraulic and pneumatic systems.
- **CLO_{04}** Analyze different types of control valves and actuators in fluid power systems.
- **CLO_{05}** Develop the ability to design, analyze, and troubleshoot fluid power circuits.

UNIT I: INTRODUCTION TO HYDRAULIC & PNEUMATIC SYSTEMS

Global fluid power Scenario, Basic system of Hydraulics-Major advantages and disadvantages, Comparison among Electrical, Hydraulics and Pneumatics System, Principles of Hydraulic Fluid power, Hydraulic Symbols, Electrical Elements used in hydraulic circuits. Basic Requirements for Pneumatic System, Basic Symbols of Pneumatic Systems, Applications of Pneumatics. Electrical elements used in Pneumatic System.

UNIT II: FLUID DYNAMICS

Fluid flow-Types of fluid flows-Newtonian and non-Newtonian fluids, Properties of fluids, Continuity equation-Bernoulli's theorem, friction factor-Moody chart, Venturi meter– Construction, principle of working, Coefficient of discharge, Discharge through venturi meter.- Orifice meter-Pitot tube – Construction, Principle of working,- hydraulic coefficients -Numerical on Bernoulli's theorem, venturi meter, orifice meter.

UNIT III: HYDRAULIC SYSTEMS

Classification of hydraulic pumps, Gear Pumps, Vane Pumps, Piston Pumps, Axial piston pumps, Hydraulic motors, Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Accumulators, Heating & cooling devices, Hoses. Types of Hydraulic Actuators, Selection criterion of Actuators, Linear and Rotary Actuators, Hydrostatic Transmission Systems.

UNIT IV: PNEUMATIC SYSTEMS

General layout of pneumatic system-Advantages of pneumatic systems, Components of pneumatic system- Compressor – Reciprocating.-construction and working of FRL unit-

working and symbols of-Control Valves – Pressure regulating valves, Flow Control valves, Direction Control Valves.-Actuators - Cylinders- single acting and double acting - Air motors,- piston motor-unit- - Pneumatic Symbols- ports and positions.

UNIT V : AUTOMATION & SIMULATION OF HYDRAULICS AND PNEUMATICS

Case study of Automation using Hydraulics and pneumatics. Introduction to software of hydraulic and Pneumatic system, Circuit designing in software, Simulation in software, Simulation with actual component using software like automation in industry.

TEXT BOOKS:

1. T. R. Chandrupatla and A. D. Belugundu, Introdution to Finite Elements in Engineering, Prentice Hall.
2. ChennakesavaR.Alavala, Finite Element Method, Prentice Hall.
3. Y.M.Desai, T.I.Eldho, A.H.Shah, Finite Element Method, Pearson

REFERENCE BOOKS:

1. G Laxmi Narasaiah, Finite Element Analysis, B.S.Publications
2. U.S.Dixit, Finite Element Methods for Engineers, Cengage Learning
3. S.S.Rao, The Finite Element Method in Engineering, Butterworth-Heinemann Elsevier

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01} Understand the basic concepts of hydraulic and pneumatic systems.

CO_{02} Classify and analyze the fluid flow and apply fluid dynamics principles.

CO_{03} Classify hydraulic components and evaluate hydraulics accessories

CO_{04} Classify pneumatic components and evaluate pneumatic accessories.

CO_{05} Utilize simulation software and theory with practices.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL17	Advance Metrology	3	0	0	3

Course Learning Objectives:

CL_{O1} To understand the principle of linear and angular measuring instruments and apply the acquired knowledge for the accurate and precise measurement of a given quantity.

CL_{O2} To understand High precision measurements such as Automated visual inspection in manufacturing, contact and non–contact type inspection methods

CL_{O3} To understand the principle of Laser Interferometer, Alignment Telescope, laser scanners for accurate and precise measurement.

CL_{O4} To understand the advances in Metrology such as use of CMM, Machine Vision System for Metrology etc.

CL_{O5} To understand the concept of Normalization, Grey scale correlation – Reflectance map concepts; surface roughness and texture characterization – photogrammetry

UNIT I: DIMENSIONAL & FORM MEASUREMENTS

Principles of dimensional and form measurements - standards - measurement errors - uncertainty in measurements - some typical examples of linear and angular measurements - introduction to geometric dimensioning and tolerancing (GD&T) - measurement and evaluation of form tolerances.

UNIT II: COMPUTER AIDED INSPECTION

High precision measurements – interfacing – software metrology – Automated visual inspection in manufacturing, contact and non – contact type inspection methods, Electrical field techniques, radiation techniques, ultrasonic – Atomic Force Microscopes (AFM), Talysurf instruments.

UNIT III: LASER METROLOGY

Laser Interferometer, Alignment Telescope, laser scanners. On-line and in – process measurements – diameter, surface roughness, Micro holes, surface topography measurements, straightness and flatness measurement, speckle measurements.

UNIT IV: COORDINATE MEASURING MACHINE

CMM Types, Applications – Non-contact CMM using Electro optical sensors for dimensional metrology – Non-contact sensors for surface finish measurements – Measurements / programming with CNC CMM – Performance evaluations – Measurement integration.

UNIT V: EDGE DETECTION TECHNIQUE

Normalization, Grey scale correlation – Reflectance map concepts; surface roughness and texture characterization – photogrammetry. Application of Machine Vision in inspection – Measurement of length, diameters, Surface roughness – automated visual inspection – 3D and dynamic feature extraction. On-line Quality control: On-line feedback quality control variable characteristics – control with measurement interval, one unit, and multiple units control systems for lot and batch production.

TEXT BOOKS:

1. Marshall A. D. and Martin R. R. – 'Computer Vision, Models and Inspection' – World Scientific
2. NelloZuech – 'Understanding and Applying Machine Vision' – Marcel Dekker

REFERENCE BOOKS:

1. John A. Bosch, Giddings, and Lewis Dayton – 'Coordinate Measuring Machines and Systems' – Marcel Dekker – 1999
2. ASTE – 'Handbook on Industrial Metrology' – Prentice Hall – 1992

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01} Students shall be able to understand the principle of linear and angular measuring instruments and apply the acquired knowledge for the accurate and precise measurement of a given quantity.

CO_{02} Students shall be able to understand High precision measurements such as Automated visual inspection in manufacturing, contact and non–contact type inspection methods

CO_{03} Students shall be able to understand the principle of Laser Interferometer, Alignment Telescope, laser scanners for accurate and precise measurement.

CO_{04} Students shall be able to understand the advances in Metrology such as use of CMM, Machine Vision System for Metrology etc.

CO_{05} Students shall be able to understand the concept of Normalization, Grey scale correlation – Reflectance map concepts; surface roughness and texture characterization – photogrammetry

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL23	Fundamental of Artificial Intelligence	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

- **CLO_{O1}** Understand the foundational concepts and principles of artificial intelligence (AI), including machine learning, natural language processing, and computer vision.
- **CLO_{O2}** Acquire knowledge of different AI techniques and algorithms used in problem-solving and decision-making tasks.
- **CLO_{O3}** Develop the ability to critically analyze AI applications and assess their ethical and societal implications.
- **CLO_{O4}** Gain practical experience in implementing AI algorithms and models using programming languages and tools commonly used in the field.
- **CLO_{O5}** Foster the skills necessary for effectively communicating AI concepts and results to both technical and non-technical audiences.

UNIT I: INTRODUCTION

Definition – Future of Artificial Intelligence, Production systems- its types & Characteristics Characteristics of Intelligent Agents. Typical Intelligent Agents

UNIT II: PROBLEM SOLVING METHODS

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems – Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal

UNIT III: KNOWLEDGE REPRESENTATION

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.

UNIT IV: SOFTWARE AGENTS

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V: APPLICATIONS

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving.

TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009.
2. Bratko, "Prolog: Programming for Artificial Intelligence", Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. M. Tim Jones, ―Artificial Intelligence: A Systems Approach (Computer Science) ‖, Jones and Bartlett Publishers, Inc.First Edition, 2008
4. Nils J. Nilsson, ―The Quest for Artificial Intelligence‖, Cambridge University Press, 2009

REFERENCE BOOKS:

1. William F. Clocksin and Christopher S. Mellish, ‖ Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003.
2. Gerhard Weiss, ―Multi Agent Systems‖, Second Edition, MIT Press, 2013.
3. David L. Poole and Alan K. Mackworth, ―Artificial Intelligence: Foundations of Computational Agents‖, Cambridge University Press, 2010.

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01} Demonstrate a comprehensive understanding of the fundamental principles and concepts of artificial intelligence, including the various subfields and techniques within the discipline.

CO_{02} Apply AI algorithms and models to solve real-world problems in different domains, demonstrating proficiency in implementing machine learning, natural language processing, and computer vision techniques.

CO_{03} Evaluate and critically analyze AI applications, considering ethical considerations, privacy concerns, and potential biases, and make informed decisions about their use.

CO_{04} Utilize programming languages and tools relevant to AI, such as Python and TensorFlow, to develop and implement AI algorithms and models.

CO_{05} Communicate effectively about AI concepts, methods, and results through oral presentations, technical reports, and documentation, catering to both technical and non-technical audiences.

SEMESTER – V

Sr. No.	Course Code	Course Name	L	T	P	Credits
1	ME3CO48	Data Science for Mechanical Engineers	3	0	2	4
2	ME3CO32	Heat & Mass Transfer	4	0	0	4
3	ME3CO33	Design and Simulation Lab-1	0	0	2	1
4	ME3CO34	Dynamics of Machine	4	0	2	5
5	ME3CO35	Thermal Lab	0	0	2	1
6	ME3ELXX	Program Elective - II	3	0	0	3
7	ME3ELXX	Program Elective - III	3	0	0	3
8		Open Elective I	3	0	0	3
9	EN3NG09	Soft Skills -III	2	0	0	2
		Total	**22**	**0**	**8**	**26**
		Total Contact Hours	**30**			

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO48	Data Science for Mechanical Engineers	2	0	2	3

Course Learning Objectives (CLO's):

CLO1 To understand the fundamentals of data science and its relevance to mechanical engineering.

CLO2 To acquire skills in data preprocessing, exploration, and visualization.

CLO3 To apply statistical analysis techniques for data interpretation.

CLO4 To gain knowledge of machine learning algorithms and their application to mechanical engineering datasets.

CLO5 To develop practical expertise in implementing data science techniques for solving mechanical engineering problems.

Unit 1: Introduction to Data Science for Mechanical Engineering. Introduction to data science and its applications in mechanical engineering. Data acquisition and data pre-processing techniques. Exploratory data analysis and data visualization. Data quality assessment and cleaning

Unit 2: Statistical Analysis for Mechanical Engineering Data. Descriptive statistics and data summarization. Probability distributions and hypothesis testing. Statistical inference and confidence intervals. Analysis of variance (ANOVA) for experimental data

Unit 3: Data Visualization in Mechanical Engineering. Visualization techniques and best practices. Plotting libraries in Python (Matplotlib, Seaborn). Interactive visualization using Plotly. Visualizing multidimensional data and correlation analysis

Unit 4: Machine Learning for Mechanical Engineering. Introduction to machine learning algorithms. Supervised learning: Regression and classification, Unsupervised learning: Clustering and dimensionality reduction. Evaluation and validation of machine learning models

Unit 5: Case Studies and Applications in Mechanical Engineering. Predictive maintenance and condition monitoring. Fault diagnosis and failure prediction. Optimization and design optimization using data-driven techniques. Decision support systems in mechanical engineering

Text Books:

1. "Python for Data Analysis" by Wes McKinney
2. "Introduction to Probability and Statistics for Engineers and Scientists"
3. by Sheldon M. Ross
4. "Python Data Science Handbook" by Jake Vander Plas
5. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
6. Case studies and research papers related to data science applications in mechanical engineering

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO01 Understand the fundamentals of data science and its relevance to mechanical engineering.

CO02 Acquire skills in data preprocessing, exploration, and visualization.

CO03 Apply statistical analysis techniques for data interpretation.

CO04 Gain knowledge of machine learning algorithms and their application to mechanical engineering datasets.

CO05 Develop practical expertise in implementing data science techniques for solving mechanical engineering problems.

List of Practicals:

1. Data Acquisition and Pre-processing Techniques:
a. Collect and pre-process sensor data from a mechanical system.
b. Perform feature extraction and selection on raw sensor data.
c. Handle missing data and outliers in a dataset.
2. Exploratory Data Analysis and Data Visualization:
a. Explore and visualize the relationships between different variables in a mechanical engineering dataset.
b. Create histograms, scatter plots, and box plots to understand the distribution and spread of data.
c. Use heatmaps and correlation matrices to identify correlations between variables.
3. Data Quality Assessment and Cleaning:
a. Evaluate the quality of a dataset by assessing missing values, duplicates, and inconsistencies.
b. Clean the dataset by imputing missing values, removing duplicates, and resolving inconsistencies.

4. Descriptive Statistics and Data Summarization:
a. Calculate and interpret descriptive statistics such as mean, median, and standard deviation for mechanical engineering data.
b. Summarize the data using measures of central tendency and variability.
5. Probability Distributions and Hypothesis Testing:
a. Fit probability distributions to mechanical engineering data and assess goodness of fit.
b. Perform hypothesis testing to compare means or proportions of different groups in a dataset.
6. Statistical Inference and Confidence Intervals:
a. Estimate population parameters and construct confidence intervals for mechanical engineering data.
b. Interpret confidence intervals in the context of mechanical engineering problems.
7. Analysis of Variance (ANOVA) for Experimental Data:
a. Conduct ANOVA to analyze the differences between multiple groups in experimental data.
b. Perform post-hoc tests to identify which groups differ significantly from each other.
8. Visualization Techniques and Best Practices:
a. Create effective visualizations for mechanical engineering data using appropriate chart types.
b. Apply best practices in data visualization, such as labeling axes, adding titles, and choosing appropriate color schemes.
9. Machine Learning Algorithms for Regression and Classification:
a. Apply regression algorithms to predict mechanical system performance based on input variables.
b. Use classification algorithms to classify mechanical components as healthy or faulty based on sensor data.
10. Unsupervised Learning: Clustering and Dimensionality Reduction:
a. Apply clustering algorithms to identify patterns or groups in mechanical engineering data.
b. Perform dimensionality reduction techniques such as Principal Component Analysis (PCA) to visualize high-dimensional data.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO48	Heat & Mass Transfer	4	0	0	4

Course Learning Objectives (CLOs):

CLO01 To understand the phenomenon of heat transfer & different modes of heat transfer.

CLO02 To understand the importance of extended surfaces & its applications.

CLO03 Apply principles of heat and mass transfer to predict transfer coefficients.

CLO04 Analyze working of various heat transfer equipment like heat exchanger.

CLO05 To understand the various laws for Radiation heat transfer.

UNIT I : CONDUCTION

Fourier heat conduction equation, its form in rectangular, cylindrical and spherical coordinates, thermal diffusivity, linear one-dimensional steady state conduction through a slab, tubes, spherical shells and composite structures, electrical analogies, critical-insulation-thickness for pipes, Lumped Parameter Analysis.

UNIT II : CONVECTION

Introduction, free and forced convection; application of dimensional analysis of free and forced convection, empirical correlations for laminar and turbulent flow over flat plate and tubular geometry; calculation of convective heat transfer coefficient using data book, Thermal Boundary layer.

UNIT III: EXTENDED SURFACES (FINS)

Heat transfer from a straight and annular fin for a uniform cross section; error in measurement of temperature in a thermometer well, fin efficiency, fin effectiveness, applications.

UNIT IV: HEAT EXCHANGERS & MASS TRANSFER

Heat exchangers: Types- parallel flow, counter flow; evaporator and condensers, overall heat transfers coefficient, fouling factors, long-mean temperature difference (LMTD), method of heat exchanger analysis, effectiveness of heat exchanger, NTU method.

Mass transfer: Fick's law, equi-molar diffusion, diffusion coefficient, analogy with heat transfer, diffusion of vapour in a stationary medium

UNIT V :THERMAL RADIATION

Nature of radiation, emissive power, absorption, transmission, reflection and emission of radiation, radiation from real surfaces; radiation heat exchange between black and gray surfaces, shape factor, radiation shields.

Text Books:

1. S.P.Sukhatme, Heat and Mass Transfer, University Press Hyderabad
2. J.P.Holman, Heat Transfer, TMH
3. R. K. Rajput, Heat and Mass Transfer, S. Chand Pub.

Reference Books:

1. Y Cengel, Heat and Mass Transfer, TMH
2. D.S.Kumar, Heat and Mass Transfer; S.K. Kataria and Sons.
3. P.K.Nag, Heat Transfer, TMH

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO01 Ability to understand and solve conduction heat transfer problems.

CO02 Ability to design and analyze thermal heat transfer cooling systems by using principle of convection.

CO03 Ability to understand the concept of natural convection and forced convection for different thermal system configurations.

CO04 Ability to design and analyze the performance of heat exchangers and Evaporators

CO05 Ability to understand and solve radiation problems.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO33	Design & Simulation Lab-I	0	0	2	1

Introduction of FEA and ANSYS
Study of a FEA package and applying it on various problems

STRUCTURAL ANALYSIS

1. Stress analysis of a plate with a circular hole
2. Stress analysis of rectangular L bracket
3. Stress analysis of an axis-symmetric component
4. Stress Analysis on Cantilever Beam Subjected To single point load and UDL
5. Stress analysis of simply supported beam Subjected To single point load and UDL
6. Stress analysis of fixed beam Subjected To single point load and UDL
7. Truss subjected to transverse load
8. Analysis of a bicycle frame
9. Application of Joints and springs in ANSYS

THERMAL ANALYSIS

1. Thermal stress analysis of a 2D component
2. Conductive heat transfer analysis of a 2D component
3. Convective heat transfer analysis of a 2D component
4. Thermal analysis of Melting Using Element Death -it is subject to convection heating which will cause the block to "melt"

VIBRATIONAL ANALYSIS

1. Model frequency analysis of 2D component
2. Harmonic analysis of a 2D component

Text Books:

1. P Seshu, Finite Element Analysis, PHI publications, Delhi
2. J N Reddy "An Introduction to finite element method" Tata Mc Graw Hill 3rd edition
3. Nitin S.Gokhale, "Practical Finite Element Analysis", Finite To Infinite Publication

4. R C Hibbeler, "Structural Analysis by Pearson", Pearson Education

Reference Books:

1. Finite Element Method with Applications in Engineering- Y M Desai, Pearson Publication
2. G. Ramamurty, Applied Finite Element Analysis, Dreamtech Press

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO34	Dynamics of Machines	4	0	2	5

Course Learning Objectives (CLO's):

CLO01 To understand the fundamental principles of kinematics as applied to machinery.

CLO02 To learn methods for analyzing velocities and accelerations in mechanisms.

CLO03 To develop skills to use graphical and analytical techniques in kinematic analysis.

CLO04 To understand the concepts of instantaneous centers and relative velocity methods.

CLO05 To understand the concepts of balancing of rotating masses inertia force and moments.

UNIT I FORCE ANALYSIS IN MECHANISMS

Static force and Inertia force, D'Alembert's Principle, Static force analysis in mechanisms. Free body diagrams and equilibrium of two, three and four force members, superposition of forces and torques, Concept of dynamically equivalent system. Inertia force analysis using graphical approach - in four bar and slider crank mechanisms.

UNIT II DYNAMIC ANALYSIS OF RECIPROCATING ENGINES

Analytical expressions of displacement, velocity and acceleration of piston, Analytical expressions of Piston effort, Connecting rod force and turning moment in engines, Turning moment diagrams of Single Cylinder and Multi-cylinder Internal combustion engines, Double acting steam engines. Coefficient of fluctuation of Energy and Speed, Flywheel and it's applications in reciprocating engines and Punching and riveting Machine.

UNIT III GOVERNER MECHANISMS

Governors and its type, Types of governors, terminology of Centrifugal Governors, Different types of centrifugal Governors- Watt, Porter, Proell, Hartnell Hartung. Gravity and spring controlled Governor their performance characteristics. Different characteristics like - Stability. Isochronism and Hunting in Governors.

UNIT IV BALANCING OF INERTIA FORCES & MOMENTS

Balancing of rotating masses: Two Plane Balancing, Balancing of several masses rotating in different planes, Balancing of reciprocating masses in single cylinder IC engines, Multi-cylinder inline engine, Radial Engine V-twin engines, Concept of firing order and harmonic balancing in multi-cylinder engine.

UNIT V FUNDAMENTAL ASPECTS OF VIBRATION

Vibration, main causes, advantages and disadvantages; engineering applications of vibration and noise; classification of vibration, vector method of representing harmonic motion; characteristics of vibration, elements of vibratory system; lumped and distributed parameter systems.

Undamped Free Vibrations: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Systems involving angular oscillations: the compound pendulum.

Text Books

1. Rattan S.S.; Theory of machines; Mc-Graw Hills Publications.
2. Ambekar A.G.; Mechanism and Machine Theory; PHI. Eastern Economy Edition 2015
3. Rao, J.S., and Dukkipati, R.V.: "Mechanism and Machine Theory", Wiley Eastern Ltd.
4. Jagdish Lal; Theory of Machines; Metropolitan Book Co; Delhi
5. Khurmi R.S. and Gupta J K; Theory of Machines ;S.Chand& Co.
6. Ambekar A.G.,' Mechanical Vibrations and Noise Engineering; PHI

Reference Books

1. Bevan T., "Theory of Machines: A text book for engineering students", 3 rd Edition, CBS, New Delhi.
2. Shigley, J.E. and Uicker, J.J. and Pennock, G. R.. "Theory of Machines and Mechanisms", 3 rd Edition, Oxford University Press, 2005.
3. Ghosh, A, and Malick, A. K. "Theory of Mechanisms and Machines" 3 rd Edition, East West Press Pvt. Ltd., 2000

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO01 Explain the basic concepts of kinematic chains and mechanisms.
CO02 Analyze the velocities and accelerations in various mechanisms.
CO03 Apply graphical and analytical methods for kinematic analysis.
CO04 Utilize the instantaneous center of velocity and relative velocity methods in solving kinematic problems.

CO05 Understand and apply the concepts of balancing of rotating masses inertia force and moments.

List of Experiments:

1. Determination of moment of inertia of flywheel by falling weight method.
2. To determine center of gravity of compound pendulum (Symmetrical and Unsymmetrical body).
3. Determination of center of percussion of long body.
4. Determination of radius of gyration of a bar using Bifilar suspension method.
5. To determine the performance characteristics of Watt, Porter and Proell Governor.
6. To determine the performance characteristics of Hartnell Governor.
7. To perform dynamic balancing of unbalanced rotating shaft.
8. To study the balancing of reciprocating masses in a reciprocating engine.
9. To determine the time period and natural frequency of undamped free vibration of equivalent spring mass system.
10. To study undamped torsional vibration of a single rotor with shaft.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3CO35	Thermal Lab	0	0	2	1

UNIT I

Experimental capabilities include study of steam generators and turbines, Performance and energy balance test on steam generators. Performance and energy balance test on steam turbines.

UNIT II

Experimental investigation of nozzle properties, jet velocity and nozzle efficiency

UNIT III

Demonstration of parts and working of compressor, Experimental investigation of compressor performance parameters

UNIT IV

Demonstration of cooling towers, Parts of cooling towers, heat exchangers, experimental investigation of performance parameters.

UNIT V

Demonstration of various condensers, Role of condensers in boiler performance.

Text Books:

1. P.K.Nag; Engineering Thermodynamics; TMH
2. B K Sarkar;Thermal Engineering; TMH
3. R K Rajput; Thermal Engineering; Laxmi Publicaions

Reference Books:

1. Van GJ; Thermodynamics; Willey Publication
2. Cengel Y; Thermodynamics; TMH
3. Moran & Shapiro; Engineering Thermodynamics, Willey Publication.

List of Experiments:

1) Performance analysis of Rankine Efficiency on a Mini Power Plant.
2) Preparation of Boiler Trial Sheet with the help of Mini Power Plant.
3) Study of High-Pressure Boilers.
4) Determination of dryness fraction of steam using electrical calorimeter.
5) Determination of efficiency of Cooling Towers.
6) Analysis of overall heat transfer coefficient in parallel and counter flow heat exchangers.

7) Performance analysis and determination of volumetric efficiency of Reciprocating compressor.
8) Determination of calorific value of fuel using Bomb Calorimeter.
9) Determination of jet velocity and efficiency of nozzle.
10) Study of various types of condensers.

PROGRAM ELECTIVE-II

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL05	Computer Graphics and Product Modelling	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's)

CLO_{01} To understand the basic concepts and applications of computer graphics.

CLO_{02} To learn various algorithms for rendering 2D and 3D objects.

CLO_{03} To gain knowledge about geometric modeling techniques.

CLO_{04} To explore the use of graphics hardware and software tools.

CLO_{05} To apply computer graphics techniques in real-world scenarios.

Unit I: Introduction to Computer Graphics and Modeling

Overview of Computer Graphics, Applications of Computer Graphics. Graphics Systems: Raster and Vector Graphics. Graphics Hardware: Input and Output Devices. Graphics Software: OpenGL, DirectX, Vulkan.

Unit II: 2D Graphics and Algorithms

Basic Concepts: Pixels, Resolution, Aspect Ratio. Line Drawing Algorithms: DDA, Bresenham's Circle and Ellipse Drawing Algorithms. Filling Algorithms: Scan-line Polygon Fill, Seed Fill. Clipping Algorithms: Cohen-Sutherland, Liang-Barsky.

Unit III: 2D and 3D Transformations

Basic Transformations: Translation, Scaling, Rotation. Composite Transformations. Homogeneous Coordinates. 3D Transformations: Translation, Scaling, Rotation. Viewing Transformations: Orthographic and Perspective Projections.

Unit IV: Geometric Modeling

Introduction to Geometric Modeling. Representations of 3D Objects: Polygonal Meshes, Curves, and Surfaces. Bezier Curves and Surfaces. B-Spline Curves and Surfaces. Solid Modeling: CSG, B-Rep.

UNIT V: Advanced Topics and Applications

Graphics Programming with OpenGL/DirectX, Shading and Rendering Techniques: Gouraud, Phong. Texture Mapping, Bump Mapping. Animation Techniques. Real-Time Rendering and Interactive Graphics.

TEXT BOOKS:

1. "Computer Graphics with OpenGL" by Donald Hearn and M. Pauline Baker
2. "Fundamentals of Computer Graphics" by Peter Shirley, Steve Marschner, et al.
3. "Computer Graphics: Principles and Practice" by John F. Hughes, Andries van Dam, et al.

REFERENCE BOOKS:

1. "OpenGL Programming Guide: The Official Guide to Learning OpenGL" by Dave Shreiner, Graham Sellers, et al.
2. "Real-Time Rendering" by Tomas Akenine-Möller, Eric Haines, et al.
3. "Geometric Modeling" by Michael E. Mortenson

COURSE OUTCOMES (CO's):

After completion of this course the students shall be able to:

CO_{01}: Describe the fundamental concepts of computer graphics.
CO_{02}: Implement algorithms for drawing 2D primitives.
CO_{03}: Utilize transformations and projections in 2D and 3D graphics.
CO_{04}: Develop and manipulate 3D models using geometric modeling techniques.
CO_{05}: Create interactive graphics applications using appropriate tools and libraries.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL12	Computational Fluid Dynamics	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's)

CLO_{01} To introduce the fundamental principles and equations governing fluid dynamics.

CLO_{02} To provide knowledge of numerical methods and algorithms used in CFD.

CLO_{03} To develop skills in using CFD software for solving practical fluid dynamics problems.

CLO_{04} To understand the application of CFD in various engineering fields.

CLO_{05} To analyze and interpret CFD results for informed decision-making.

UNIT I INTRODUCTION TO CFD

CFD as third dimension of engineering supplementing theory and experiment, Steps in CFD solution procedure, strengths and weakness of CFD, Flow modelling using control volume - finite and infinitesimal control volumes, Concept of substantial derivative, divergence of velocity, Basic governing equations in integral and differential forms – conservation of mass, momentum and energy (No derivations), Physical interpretation of governing equations, Navier-Stoke's model and Euler's model of equations.

UNIT II BASIC DISCRETIZATION TECHNIQUES

Introduction to grid generation (Types of grids such as structured, unstructured, hybrid, multiblock, Cartesian, body fitted and polyhedral etc.), Need to discretize the domain and governing equations, Finite difference approximation using Taylor series, for first order (Forward Difference Approximation, Backward Difference Approximation, Central difference Approximation) and second order (based on 3 node, 4 node and 5 node points),explicit and Implicit approaches applied to 1D transient conduction equation, Couette flow equation using FTCS and Crank Nicholson's Method, Stability Criteria concept and physical interpretation, Thomas Tri-diagonal matrix solver.

UNIT III 3D TWO DIMENSIONAL STEADY & UNSTEADY HEAT CONDUCTION

Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann, robbins and mixed boundary condition – solution by Explicit and Alternating

Direction Implicit method (ADI Method), Approach for irregular boundary for 2D heat conduction problems.

UNIT IV APPLICATION OF NUMERICAL METHODS TO CONVECTION

Diffusion System Convection: first order wave equation solution with upwind, Lax–Wendroff, Mac Cormack scheme, Stability Criteria concept and physical interpretation Convection –Diffusion: 1D and 2D steady Convection Diffusion system – Central difference approach, Peclet Number, stability criteria, upwind difference approach, 1 D transient convection-diffusion system.

UNIT V ORGANIZING PRODUCT DEVELOPMENT

Solution of Navier-Stoke‘s equation for incompressible flow using SIMPLE algorithms and its variation (SIMPLER), Application to flow through pipe, Introduction to finite volume method. Introduction to any CFD tool, steps in pre-processing, geometry creation, mesh generation, selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness, initializing and solution control for the solver, Residuals, analyzing the plots of various parameters (Scalar and Vector contours such as streamlines, velocity vector plots and animation). Introduction to turbulence models. Reynolds Averaged Navier-Stokes equations (RANS), k-ϵ , k-ω . Simple problems like flow inside a 2-D square lid driven cavity flow through the nozzle.

Text Books

1. John D Anderson: Computational Fluid Dynamics- The Basics with Applications, McGraw Hill.
2. J. Tu, G.-H. Yeoh and C. Liu: Computational Fluid Dynamics: A practical approach, Elsevier.
3. W. Date: Introduction to Computational Fluid Dynamics, Cambridge University Press, India.
4. P. S. Ghoshdastidar: Computer Simulation of Fluid flow and heat transfer, Tata McGraw-Hill.

Reference Books

1. Bates, Computational Fluid Dynamics, Wiley India.
2. C. Hirsch: Numerical Simulation of internal and external flows Vol. 1, John Wiley.
3. Tannehill, Anderson, and Pletcher: Computational Fluid Mechanics and Heat transfer, CRC Press.
4. J. H. Ferziger and M. Peric: Computational Methods for Fluid Dynamics, 3rd Edition, Springer.

5. Zikanov, Essential Computational Fluid Dynamics, Wiley India.
6. Batchelor, An Introduction to fluid Dymanics, Cambridge Uni. Press, India.

COURSE OUTCOMES (CO's):

After completion of this course the students shall be able to:

CO01: Explain the fundamental principles and governing equations of fluid dynamics.
CO02: Apply numerical methods to discretize and solve fluid dynamics problems.
CO03: Utilize CFD software to model and simulate fluid flow in different scenarios.
CO04: Analyze CFD results to evaluate fluid behavior and performance of systems.
CO05: Demonstrate the application of CFD in solving real-world engineering problems.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL18	Production Planning and Control	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's)

CLO_{01} To understand the fundamental concepts and techniques of production planning and control.

CLO_{02} To develop skills in designing and managing production systems.

CLO_{03} To analyze and apply forecasting, inventory control, and scheduling methods.

CLO_{04} To learn the principles of capacity planning and materials requirement planning (MRP).

CLO_{05} To enhance decision-making abilities related to production planning and control in various industries.

UNIT I INTRODUCTION

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

UNIT II PROCESS DESIGN

Systems approach to process planning and design, linkage between product planning and process planning, distinction between process planning and facilities planning, types of process design, process design procedure. Break even analysis-Economics of a new design.

UNIT III FORECASTING

Characteristics of demand over time, forecasting qualitative model: Delphi, naive quantitative models: simple average, simple moving average, weighted moving average, exponential smoothing, smoothing coefficient selection, adaptive exponential smoothing, incorporating trend and seasonal components, linear regression, selection of forecasting models.

UNIT IV PRODUCTION SCHEDULING

Production Control Systems, Loading and scheduling, Master Scheduling, Scheduling rules, Gantt charts-Perpetual loading, Basic scheduling problems, Line of balance, Flow production scheduling, Batch production scheduling, Product sequencing, Production Control systems, Periodic batch control, Routing, Loading, Scheduling, forward and backward, Dispatching,

priority rules, Sequencing, Johnson's algorithm for n jobs and two machines, Gantt's chart, Bar chart, Flow process chart.

UNIT V WORK STUDY

Method study, basic procedure, Selection-Recording of process, Critical analysis, Development, Implementation, Micro motion and memo motion study, work measurement, Techniques of work measurement, Time study, Production study, Work sampling, Synthesis from standard data, Predetermined motion time standards.

Text Books

1. V. Thomas , B. William, D Clay, "Manufacturing Planning and Control Systems" Galgotia Publications, New Delhi.
2. W.J. Stevensons, Operations Management, Mc-Graw Hills.
3. M.Telsang, Industrial Engineering and Production Management, S. Chand Publications.

Reference Books

1. Introduction to Work Study by ILO.
2. S.N. Chapman, Fundamentals of Production Planning and Control, Pearson
3. L. C. Jhamb, Production Planning and Control, Everest Publishing House

COURSE OUTCOMES (CO's):

After completion of this course the students shall be able to:

CO01: Explain the basic concepts and objectives of production planning and control.
CO02: Apply forecasting techniques to predict future production requirements.
CO03: Implement inventory control methods to manage stock levels effectively.
CO04: Develop and optimize production schedules to enhance efficiency.
CO05: Utilize capacity planning and MRP techniques to ensure timely production.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
ME3EL24	Cyber Physical Production Systems	3	0	0	3

Course Learning Objectives (CLO's):

CLO_{01} Understand the key principles and concepts of cyber-physical systems (CPS) and their application in the context of production systems.

CLO_{02} Analyze the benefits and challenges associated with the integration of cyber and physical components in production processes.

CLO_{03} Gain knowledge of communication networks, sensors, actuators, and control systems used in cyber-physical production systems (CPPS).

CLO_{04} Design and develop architectures for effective integration and interoperability of cyber and physical components in production systems.

CLO_{05} Apply modeling and simulation techniques to analyze and optimize the performance of cyber-physical production systems.

UNIT I INTRODUCTION

Cyber-Physical System, Key Features of CPS, Application Domains of CPS, Basic principles of design and validation of CPS, Challenges in CPS.

UNIT II CPS PLATFORM COMPONENTS

CPS HW platforms, Processors, Sensors and Actuators, CPS Network - Wireless, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks, Synchronous Model and Asynchronous Model.

UNIT III SYNCHRONOUS & ASYNCHRONOUS MODEL

Reactive Components, Components Properties, Components Composing, Synchronous Designs and Circuits, Asynchronous Processes and operations, Design Primitives in Asynchronous Process, Coordination Protocols in Asynchronous Process, Leader Election, Reliable Transmission.

UNIT IV SECURITY OF CYBER-PHYSICAL SYSTEMS

Introduction to CPS Securities, Basic Techniques in CPS Securities, Cyber Security Requirements, Attack Model and Countermeasures, Advanced Techniques in CPS Securities.

UNIT V CPS APPLICATION

Health care and Medical Cyber-Physical Systems, Smart grid and Energy CyberPhysical Systems, WSN based Cyber-Physical Systems, Smart Cities.

Text Books:

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
2. R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
3. Raj Rajkumar, Dionisio de Niz and Mark Klein, "Cyber-Physical Systems", Addison-Wesley, 2017

Reference Books:

1. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, 2015
2. Fei Hu, "Cyber-Physical Systems", CRC Press 2013

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Explain the fundamental principles and concepts of cyber-physical systems (CPS) and their relevance to production systems.

CO_{02} Evaluate the advantages and challenges associated with integrating cyber and physical components in production processes.

CO_{03} Demonstrate an understanding of communication networks, sensors, actuators, and control systems used in cyber-physical production systems (CPPS).

CO_{04} Design architectures that enable seamless integration and interoperability between cyber and physical components in production systems.

CO_{05} Apply modeling and simulation techniques to analyze and optimize the performance of cyber-physical production systems.

PROGRAM ELECTIVE-III

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL25	Additive manufacturing	3	0	0	3	3

Course Learning Objectives (CLO's):

CLO_{01} To understand the fundamental principles and technologies of additive manufacturing (AM).

CLO_{02} To understand the various AM processes and their applications.

CLO_{03} To develop skills in designing for additive manufacturing (DfAM).

CLO_{04} To explore material properties and selection criteria for AM.

CLO_{05} To analyze and evaluate the advantages, limitations, and challenges of AM technologies.

INTRODUCTION TO ADDITIVE MANUFACTURING (AM)

Fundamentals of AM process, History and Classification, Subtractive vs Additive Manufacturing; Generation of the physical layer model; Data Processing: CAD Model Preparation – AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation – Support Structure – Slicing; Effect of part deposition orientation on accuracy, surface finish, build time, support structure, cost etc. Various Rapid tooling techniques; Reverse Engineering : Introduction to Reverse Engineering; Reverse engineering and Additive Manufacturing, AM vs Reverse Engineering.

UNIT II LIQUID AND SOLID BASED AM SYSTEMS

Classification of Liquid-based AM System , (i) Stereolithography - Working Principle, advantages & disadvantages ; Classification of Solid based AM system, Working Principle, advantages & disadvantages of (i) Fused Deposition Modeling (FDM) / Fused Filament Fabrication (FFF) (ii) Laminated Object Manufacturing (LOM) , Materials for solid and liquid based AM, Application.

UNIT III : POWDER-BASED AM SYSTEMS

Classification of Powder-based AM System: Working Principles of Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Selective Laser Melting (SLM), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM). Materials used in Powder based AM System and Application areas.

UNIT-IV DIRECT ENERGY DEPOSITION (DED)

Principle of DED system and benefit over other AM processes, Working principle of Wire Arc Additive Manufacturing (WAAM), Wire Laser AM. Difference between DED and Powder Bed AM process, Materials used in DED AM System and Application areas.

UNIT-V DEFECTS IN AM PARTS AND POST-PROCESSING TECHNIQUES

Defects – Types of defects during the AM process (including designing and manufacturing defects). Post Processing - Various in-situ and ex-situ techniques, different types of post processing techniques (including machining, heat treatment and surface treatment).

Text Books:

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. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 201.
4. Laser Induced Materials and Processes for Rapid Prototyping by Fuh and Wong, Kluwer Academic Press.

Reference Books:

1. L. Lu, J. Fuh and Y. S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 2001.
2. Laser Assisted Fabrication of Materials by Majumdar and Manna, Springer Series in Material Science.
3. Numerical modeling of the additive manufacturing (AM) processes of titatium alloy, Zhiqiang Fan and Frank Liou.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Select appropriate additive manufacturing processes.
CO_{02} Select and use the correct CAD formats to manufacture a 3D-printed part.
CO_{03} Understand the capabilities, and limitations of different additive manufacturing technologies
CO_{04} Determine an appropriate technique for efficient bio-manufacturing.
CO_{05} Identify the causes of defects in AM

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL13	Power Plant Engineering	3	0	0	3	3

Course Learning Objectives (CLO's):

CLO_{01}: To provide a comprehensive understanding of various types of power plants and their operation.

CLO_{02}: To analyze the components and working principles of power plants.

CLO_{03}: To understand the environmental impact and sustainability of power generation.

CLO_{04}: To learn about the economics and management of power plants.

CLO_{05}: To develop problem-solving skills related to power plant operation and maintenance.

Unit I: Introduction to Power Plants:

Overview of Power Generation, Classification of Power Plants, General Layout and Components of Power Plants, Energy Conversion Processes. Basic Thermodynamic Cycles: Rankine, Brayton, Combined Cycles

Unit II: Thermal Power Plants:

Introduction to Thermal Power Plants, Components: Boilers, Turbines, Condensers, Cooling Towers. Rankine Cycle Analysis. Fuel Types and Combustion Processes. Efficiency and Performance of Thermal Power Plants.

Unit III: Hydroelectric and Nuclear Power Plants

Hydroelectric Power Plants: Types, Components, Working Principles, Dams and Reservoirs, Hydraulic Turbines, Governors. Nuclear Power Plants: Types, Components, Working Principles, Nuclear Reactors, Fuel Cycle, Safety Measures, Environmental and Safety Issues in Hydroelectric and Nuclear Power Plants.

Unit IV: Renewable Energy Power Plants

Introduction to Renewable Energy Sources. Solar Power Plants: Photovoltaic and Solar Thermal Systems. Wind Power Plants: Wind Turbines, Wind Farms. Geothermal Power Plants: Working Principles, Components. Biomass and Waste-to-Energy Plants.

Unit V: Economics and Management of Power Plants

Power Plant Economics: Cost Analysis, Economic Load Dispatch, Tariff Methods and Power Purchase Agreements, Maintenance and Reliability of Power Plants. Environmental Regulations and Emission Standards, Future Trends and Technological Advancements in Power Generation.

Text Books:

1. "Power Plant Engineering" by P.K. Nag
2. "Power Plant Technology" by M.M. El-Wakil
3. "Power Plant Engineering" by Domkundwar and Arora.
4. "Electric Power Generation, Transmission, and Distribution" by Leonard L. Grigsby

Reference Books:

1. "Standard Handbook of Power Plant Engineering" by Thomas C. Elliott, Kao Chen, and Robert Swanekamp
2. "Energy Systems Engineering: Evaluation and Implementation" by Francis Vanek and Louis Albright
3. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01}: Describe the different types of power plants and their basic principles.
CO_{02}: Explain the components and working principles of thermal, hydroelectric, nuclear, and renewable energy power plants.
CO_{03}: Evaluate the environmental impact and sustainability of different power generation methods.
CO_{04}: Analyze the economics and management aspects of power plants.
CO_{05}: Apply knowledge to solve problems related to power plant operation and maintenance.

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL19	Operations Management	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO_{01} To familiarize with the concept of Production and operations management, product and process
CLO_{02} To Gain the knowledge of system design.
CLO_{03} To Understand about service operations and quality management tools.
CLO_{04} To Apply the concepts of forecasting, line balancing, facility location and layout.
CLO_{05} To Apply the concepts of project management, MRP and product structure.

UNIT I INTRODUCTION

Operations Management: Introduction and overview, Operations Management Strategy framework, Responsibilities of operation manager Understanding similarities and difference among goods and services, Historical evolution of operations management-Changes & Challenges.

UNIT II PRODUCT DEVELOPMENT

Operations strategy, Product Strategy and integrated product development, Process Strategy, Systematic approach to capacity planning, Capacity Decisions, Facilities Location Strategies, BPO, DFM, DFE, 3'S

UNIT III SYSTEM DESIGN

Facilities Layout and Material Handling Strategy, Group Technology, Flexible manufacturing system, Assembly line balancing, Project Management-CPM PERT, Line of Balance (LOB). Traditional v/s Concurrent Design, form & functional design, simplification & standardization

UNIT IV PLANNING AND MANAGING OPERATIONS

Purchasing, vendor selection and material management, Just-in-Time Systems, MPS. Materials Requirement Planning, MRP II and ERP Aggregate Operations Planning, Product structure tree.

UNIT V ADVANCE OPERATION MANAGEMENT

Service Operations Management, Lean systems, Constraint management – TOC, Computer integrated manufacturing, Analytical tools for decision support system (DSS) for operations management, Kanban and CONWIP, shop floor controls, Kaizen.

Text Books:

1. Chary S N , Production and Operations Management, Tata Mc Graw Hill
2. Chase, Jacobs and Aquilano, Operations Management for Competitive advantages, Tata Mc Graw Hill
3. Everett Adam, Ronald J Ebert, Production and Operations Management Prentice Hall

Reference Books:

1. Joseph G. Monks, Operations Management Theory and Problems, Mc. Graw Hill .
2. William J Stevenson, Operations Management Concepts, McGraw Hill
3. Norman Gaither, Greg. Frazier , Operation Management, Thomson

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand Production and operations management, product and process.
CO_{02} Understand System design and its concepts.
CO_{03} Understand Quality and service management
CO_{04} Apply knowledge of forecasting, line balancing, facility location and layout
CO_{05} Apply the concepts of project management, MRP and product.

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL25	Additive manufacturing	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO_{01} To understand the concepts of additive manufacturing technologies.

CLO_{02} To understand the defects and post-processing techniques

CLO_{03} To explore the materials used in additive manufacturing and their properties.

CLO_{04} To develop the skills to design and fabricate components using additive manufacturing techniques.

CLO_{05} To analyze the benefits and limitations of additive manufacturing compared to traditional manufacturing methods.

UNIT I INTRODUCTION TO ADDITIVE MANUFACTURING (AM)

Fundamentals of AM process, History and Classification, Subtractive vs Additive Manufacturing; Generation of the physical layer model; Data Processing: CAD Model Preparation – AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation – Support Structure – Slicing; Effect of part deposition orientation on accuracy, surface finish, build time, support structure, cost etc. Various Rapid tooling techniques; Reverse Engineering: Introduction to Reverse Engineering; Reverse engineering and Additive Manufacturing, AM vs Reverse Engineering.

UNIT II LIQUID AND SOLID BASED AM SYSTEMS

Classification of Liquid-based AM System , (i) Stereolithiography - Working Principle, advantages & disadvantages ; Classification of Solid based AM system, Working Principle, advantages & disadvantages of (i) Fused Deposition Modeling (FDM) / Fused Filament Fabrication (FFF) (ii) Laminated Object Manufacturing (LOM) , Materials for solid and liquid based AM, Application.

UNIT III : POWDER-BASED AM SYSTEMS

Classification of Powder-based AM System: Working Principles of Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Selective Laser Melting (SLM), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM). Materials used in Powder based AM System and Application areas.

UNIT-IV DIRECT ENERGY DEPOSITION (DED)

Principle of DED system and benefit over other AM processes, Working principle of Wire Arc Additive Manufacturing (WAAM), Wire Laser AM. Difference between DED and Powder Bed AM process, Materials used in DED AM System and Application areas.

UNIT-V DEFECTS IN AM PARTS AND POST-PROCESSING TECHNIQUES

Defects – Types of defects during the AM process (including designing and manufacturing defects). Post Processing - Various in-situ and ex-situ techniques, different types of post processing techniques (including machining, heat treatment and surface treatment).

Text Books:

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.
4. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 201.
5. Laser Induced Materials and Processes for Rapid Prototyping by Fuh and Wong, Kluwer Academic Press.

Reference Books:

1. L. Lu, J. Fuh and Y. S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 2001.
2. Laser Assisted Fabrication of Materials by Majumdar and Manna, Springer Series in Material Science.
3. Numerical modeling of the additive manufacturing (AM) processes of titatium alloy,Zhiqiang Fan and Frank Liou.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Select appropriate additive manufacturing processes.
CO_{02} Select and use the correct CAD formats to manufacture a 3D-printed part.
CO_{03} Understand the capabilities, and limitations of different additive manufacturing technologies
CO_{04} Determine an appropriate technique for efficient bio-manufacturing.
CO_{05} Identify the causes of defects in AM

OPEN ELECTIVE-I

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
OE00083	Value Creation through Design Thinking	3	0	0	3	3

Course Learning Objectives (CLOs):

CLO_{01} To understand the concepts of design thinking and Stages of the design thinking processes.

CLO_{02} To understand the concepts and rules of brainstorming and advanced brainstorming techniques.

CLO_{03} To understand the concepts of prototyping techniques and minimum viable product.

CLO_{04} To understand the concepts of business model canvas and Pivoting.

CLO_{05} To understand the concepts of product development processes.

Unit 1: Define Your Innovation: Overview of Design Thinking, Identifying an Innovation Challenge, Needs Finding, Identifying Assumptions

Identifying Customer Needs: Learn to identify customer needs and draft customer needs statements as your first step towards user innovations.

Design Thinking Skills: Understand the critical design thinking skills needed to either improve an existing product or design a new product, Principles and Stages of the Design Thinking Process

Unit 2: Ideate: Rules of Brainstorming, Brainstorm Facilitation, Advanced Brainstorming Techniques

Applied Creativity: Learn to apply creativity, brainstorming, and concept generation process in designing needs solutions.

Product Specifications: Learn how to translate user needs into product specifications quantitatively, and how establishing product metrics can help to define those specifications.

Unit 3: Prototype: Introduction to Prototyping, Prototyping Techniques, Testing Prototypes, Explore prototyping methods, strategies, and real-life examples where these have been applied to create a design that represents customer needs and product specifications.

Test: Minimum Viable Product (MVP), MVP Testing and Iteration

Unit 4: Business Model Canvas: Learn the Business Model Canvas and How to use it to Design & Develop Solutions

Experiments: Testing Your Business Model, Introduction to Experimental Design, Types of Experiments, When to Pivot After Experimentation, Types of Pivots
Design for Services: Understand design of services, identify the potential for innovations within them, and learn how to apply product development frameworks to the service context.

Unit 5: Design for Environment: Learn how to apply design for environment principles to a product life cycle.
Product Development Processes: Learn to select and implement a product development process (staged, spiral, and agile) that's aligned to your project needs.

Text Books:

1.Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India Private Limited-2020.
2.Don Norman, The Design of Everyday Things, -2014.
3.Nigel Cross, Design Thinking: Understanding How Designers Think and Work- 2019.

Reference Books:
1. Michael Lewrick, Design Thinking for Business Growth: How to Design and Scale Business Models and Business Ecosystems, 1st Edition-2022.
2.Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef, Bernhard Schindlholzer , Design Thinking: The Handbook-2020.
3. Isabell Osann, Lena Mayer, Inga Wiele, The Design Thinking Quick Start Guide: A 6-Step Process for Generating and Implementing Creative Solutions -2020.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To understand the concepts of design thinking and Stages of the design thinking processes.
CO_{02} To understand the concepts and rules of brainstorming and advanced brainstorming techniques.
CO_{03} To understand the concepts of prototyping techniques and minimum viable product.
CO_{04} To understand the concepts of business model canvas and Pivoting.
CO_{05} To understand the concepts of product development processes.

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
OE00007	Mechanical Estimation and Costing	3	0	0	3	3

Course Learning Objectives (CLOs):

CLO_{01} To present a problem oriented in depth knowledge of Engineering Costing & Estimating.
CLO_{02} To address the underlying concepts, methods and application of Engineering Costing & Estimating.
CLO_{03} To gain awareness in Estimating cost for new project, lab development, and services.
CLO_{04} To gain awareness in different elements of cost, direct cost and indirect cost for industry.
CLO_{05} To gain awareness in Depreciation, obsolescence and calculating material cost using Menstruation.

UNIT I:

Introduction to Estimation and Costing: Estimation - Definition, Importance and Aims, Qualities and functions of an Estimator, Source of errors in estimation, Constituents of Estimation, Costing - Definition and Aims, Standard cost and its Advantages, Difference between estimation and costing, Advantages of efficient costing.

UNIT II

Elements of Costs: Elements of cost- material, labour and overhead, and examples, Calculation of Material cost-direct, indirect material, Labour - direct, indirect labour and examples, Calculation of labour cost, Overheads - direct, indirect and examples, Classification of overheads - factory, administrative, selling and distribution overheads and example, Fixed and variable overheads and examples, Components of cost - prime cost, factory cost, office cost, total cost, Selling price, Block diagram to show the relationship between elements and components of cost, Numerical problems on above, Allocation of on-cost (overhead) - methods and numerical problems.

UNIT III

Mechanical Estimation: Estimation in machine shop - Definition of cutting speed, feed,depth of cut, Estimation of time for various operations like Turning, Knurling, Facing, Drilling, Boring, Reaming, Threading, Tapping, Milling, Grinding, Shaping and Planing, Estimate the material required for- Sheet metal operation, Cylindrical drum, funnel and tray,

Estimation in foundry shop, Estimation in welding shop - gas welding and arc welding - Numerical problems.

UNIT IV

Indirect Expenses and Depreciation: Explain indirect expenses- depreciation,obsolescence, inadequacy, idleness, repair and maintenance, define depreciation and state its causes, (Physical and functional), Explain methods of calculating depreciation, Solve numerical problems on each method.

UNIT V

Mensuration And Estimation Of Material Cost: Mention Area of irregular and planefigures with sketches, Mention Volume and surface area of solids (formulae only), Estimate the material costs of step pulley, spindle lathe centre, Rivets, Fly wheel, crankshaft, chain link, wedge and Gib-headed key-Simple problems only.

Text Books:

1. B.P. Sinha, Mechanical Estimation and Costing, TMH.

2. S.K. Sharma & Savita Sharma, Industrial Engineering & Operations management, Kataria publishers.

3. T.R. Banga and S.C. Sharma, Industrial Organization and Engineering Economics, Khanna Pub.

Reference Books:

1. Shrimali and Jain, Mechanical estimating and costing, Khanna Publishers.

2. Singh and Khan, Mechanical costing and estimation, Khanna Publishers.

3. Dennis Lock, Handbook of Engineering Management, Butterwork & Heinemanky Ltd.

Course Outcomes (CO's):

After completion of this course the students shall be able to:

- **CO_{01}** Understand estimation and types of estimates in day do day life.
- **CO_{02}** Gain knowledge of different types cost and calculate the selling price of product or services.
- **CO_{03}** Gain awareness in applications of estimation and costing in mechanical processes.

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
EN3NG09	Soft Skills-III	3	0	0	3	3

SEMESTER – VI

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3CO49	Computer Integrated Manufacturing	3	0	0	3
2	ME3CO50	Refrigeration & Air Conditioning	4	0	2	5
3	ME3CO38	Design and Simulation Lab -II	0	0	2	1
4	ME3CO39	Machine Design	4	0	0	4
5	ME3ELXX	Program Elective - IV	3	0	0	3
6	ME3ELXX	Program Elective - V	3	0	0	3
7		Open Elevtive- II	3	0	0	3
8	ME3PC11	Mini Project	0	0	4	2
9	EN3NG08	Soft Skills -IV	2	0	0	2
		Total	**22**	**0**	**8**	**26**
		Total Contact Hours	**30**			

Course Code	Course Name	Hours per Week			Total Hrs	Total Credits
		L	T	P		
ME3CO49	Computer Integrated Manufacturing	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLOs):

CLO_{01} To develop an ability to apply knowledge of fundamentals of Production system to modern manufacturing organization
CLO_{02} To understand the life of product cycle and management. To study various ways of employing computer in different aspect of engineering
CLO_{03} To understand and apply NC, CNC machine and its part programming fundamentals
CLO_{04} To understand different types of Rapid prototyping methodology
CLO_{05} To understand the steps involved in the implementation and integration of a CIM system within a manufacturing environment.

UNIT I INTRODUCTION

Information requirements of manufacturing organizations; business forecasting and aggregate production plan; MPS, MRP and shop floor/ Production Activity Control (PAC); Mfg as a system, productivity and wealth creation; production processes on volume-variety axes; importance of batch and job shop production; CIM definition and CIM wheel, evolution and benefits.

UNIT II PRODUCT LIFE CYCLE (PLC)

Design for manufacturing (DFM) and concurrent engg; product design in conventional and CIM environment; terms like CAD, CAE, CAM, CAP, CAPP, CATD and CAQ.

Unit III NUMERIC CONTROL AND PART PROGRAMMING

Principles of NC machines, CNC, DNC; NC modes of point to point, -line and 2D, 3D contouring; NC part programming; ISO standard for coding, preparatory functions(G)-motion, dwell, unit, preset, cutter compensation, coordinate and plane selection groups; miscellaneous (M) codes; CLDATA and tool path simulation; ISO codes for turning tools and holders; ATC, modular work holding and pallets; time and power estimation in milling, drilling and turning; adaptive control, sequence control and PLC; simple part programming examples.

Unit IV GROUP TECHNOLOGY

Importance of batch and job shop production; merits of converting zigzag process layout flow to smooth flow in cellular layout, Production Flow Analysis (PFA) and clustering methods;

concept of part families and coding; hierarchical, attribute and hybrid coding; OPITZ, MICLASS and DCLASS coding; FMS; material handling; robots, AGV and their programming; agile mfg; Computer Aided Process Planning (CAPP), variant/ retrieval and generative approach

Unit V RAPID PROTOTYPING

Introduction, basic concepts, Need - Development of Rapid Prototyping systems, Rapid Prototyping process chain - Impact of Rapid Prototyping on Product Development –Digital prototyping - Virtual prototyping- Rapid Tooling - Benefits-Applications. Stereolithography (SLA), Solid Ground Curing (SGC), Fused deposition Modeling (FDM), Laminated object manufacturing (LOM), Selective Laser Sintering (SLS), Powder based 3DP systems.

Text Books:

1. S.Kant Vajpay; Principles of CIM; PHI
2. PN Rao CAD/CAM;TMH
3. MP Groover ; Automation, Production Systems & CIM; P.H.I.

Reference Books:

1. PN Rao , NK Tiwari , TK Kundra ; Computer Aided Manufacturing; TMH
2. A Alavudeen, N Venkteshwarn; Computer Integrated Mfg; PHI
3. P Radhakrishnan, S Subramanian and V Raju ; CAD/CAM/CIM; New age Pub

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To understand manufacturing and CIM Concept
CO_{02} To understand Numeric control technique
CO_{03} To analyze the part drawing for CNC Part programming
CO_{04} To generate the Part Program for various machining operations
CO_{05} To create work part on CNC machine by Part programming concepts

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
ME3CO50	Refrigeration and Air Conditioning	3	0	2	5	4

COURSE LEARNING OBJECTIVES (CLOs):

CLO 01 To understand different methods of refrigeration and air conditioning.
CLO 02 To understand and evaluate performance of various refrigeration cycles.
CLO 03 Comparative study of different refrigerants
CLO 04 Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
CLO05 Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

UNIT I INTRODUCTION & AIR REFRIGERATION CYCLES
Different methods of refrigeration, EER, COP, Tonne of refrigeration, Carnot air cycle, Joule's cycle or Bell Coleman cycle, Boot-strap cycle, Reduced ambient cycle and Regenerative cooling cycle.

UNIT II VCR Cycles
Carnot cycle with vapor as a refrigerant, Rankine cycle with p-v and T-s diagram, p-h diagram, subcooling and superheating, effects of condenser and evaporator pressure on COP, Liquid suction heat exchanger, Actual VCR cycle on T-s and p-h diagram. . Refrigerants: nomenclature & classification, desirable properties, common refrigeration, Environment friendly refrigerants.

UNIT II VAPOR ABSORPTION SYSTEM & MULTI PRESSURE SYSTEM
Vapour absorption system: Theoretical and practical systems such as aqua-ammonia, Electrolux & other systems. Removal of flash gas, Multiple expansion & compression with flash inter cooling; Low temperature refrigeration: Production of low temperatures, Cascade system

UNIT IV PSYCHROMETRY AND COMFORT AIR CONDITIONING
Air properties, Psychrometric chart, Psychrometric processes: Sensible heating and cooling, Evaporative cooling, Cooling and dehumidification, Heating and humidification, Mixing of air stream, Sensible heat factor. Comfort Air Conditioning; Mechanism of Body Heat Loss, Unit of Metabolic Heat Generation, Effective Temperature, Comfort Chart.

UNIT V AIR CONDITIONING SYSTEM AND AIR CONDITIONING LOADS
Air conditioning system & its Types, Air conditioning loads: calculation of summer & winter air conditioning load, bypass factor of coil, calculation of supply air rate & its condition,

room sensible heat factor, grand sensible heat factor, effective sensible heat factor, dehumidified air quantity. Problems on cooling load calculation.

Text Books:

1. C.P. Arora, Refrigeration and Air conditioning, Tata McGraw-Hill Publisher, Company, New Delhi, 4e, 2006
2. Edward G. Pita, Air Conditioning Principles and systems, Parson Education Pte. Ltd., Indian Branch, 482 F.I.F. Patparganj.
3. W.F. Stoecker, Refrigeration and Air conditioning, McGraw-Hill Book Company, 1e, 1985.
4. Manohar Prasad, Refrigeration & Air Conditioning, New Age International (P) Limited, Publishers, 7/30 A, Daryaganj, New Delhi -10002.
5. PL Balani, Refrigeration & Air conditioning, Khanna Publishers, 2-B Nath Market, Nai Sadak, Delhi - 110006

List of Practical's:-

1. Determination of COP of three fluid ELECTROLUX absorption refrigeration systems.
2. Study of various components and working of simple vapor compression cycle refrigeration trainers.
3. Determination of COP of simple vapor compression cycle refrigeration system on the trainer.
4. Study of various components and working of thermoelectric based refrigeration systems on hot & cold water dispensers.
5. Study of various components and working of air conditioning systems on re-circulated type trainers.
6. Plotting the change in the psychometric properties of air under sensible heating, sensible cooling and heating with humidification on a re-circulated type air conditioning trainer
7. Study the various components and working of window air conditioning systems.
8. Study the various components and working of three fluid ELECTROLUX absorption refrigeration systems.
9. Study of Steam Jet Refrigeration system.
10. Study of Domestic Refrigerators.

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO 01 Understand the refrigeration and air conditioning system
CO 02 To evaluate coefficient of performance of vapor compression refrigeration systems
CO 03 Select suitable refrigerants for different applications
CO 04 Calculate cooling load for air conditioning systems used for various applications.
CO 05 Operate and analyze the refrigeration and air conditioning systems.

Course Code	Course Name	Hours per Week			Total Hrs.	Total Credits
		L	T	P		
ME3CO38	Design and Simulation Lab -II	0	0	2	2	1

COURSE LEARNING OBJECTIVES (CLO$_S$):

CLO $_{01}$ To understand the fundamental concepts of simulation.
CLO $_{02}$ To acquire the skills to navigate important features of simulation software.
CLO $_{03}$ To conduct statistical assessments on the gathered data.
CLO$_{04}$ To analyze the manufacturability of designs and optimize them for production processes.
CLO$_{05}$ To Become proficient in industry-standard software for design and simulation.

LIST OF EXPERIMENTS:

1) Analysis of laminar fluid flow in straight pipe in Ansys workbench fluent
2) Analysis of turbulent fluid flow in straight pipe in Ansys workbench fluent
3) Analysis of fluid flow in a straight pipe in Ansys workbench CFX.
4) Analysis of fluid flow in helical pipe in Ansys workbench fluent
5) Analysis of flow in venturi meter for Pressure gradient and velocity Gradient
6) Analysis of 3-D Airfoil wing and calculate the coefficient of drag and coefficient of lift
7) Analysis of various Car Bodies for the Lift and Drag Force
8) Analysis of Ceiling fan air thrown in a Room
9) Analysis of Centrifugal Pump water Throw
10) Analysis of any one hydraulic turbine

Text Books:

1. Introduction to Computational Fluid Dynamics- Anil W. Date, Cambridge University Press
2. Finite Element Analysis - P Seshu, PHI publications, Delhi
3. Introduction to Computational Fluid Dynamics: Development, Application and Analysis- Atul Sharma, Wiley

References:

1. Finite Element Method in Machine Design"- V.Ramamurti, Norosa Publishing House
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method- H. Versteeg, Pearson

3. Applied Computational Fluid Dynamics- S. C. Gupta, Wiley publication

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO 01 Develop mathematical models for simulating real-world systems.
CO 02 Demonstrate proficiency in using simulation tools to model and analyze complex systems.
CO 03 Analyze simulation data, draw conclusions based on the results.
CO 04 Work effectively in teams to design, implement, and analyze simulation studies.
CO 05 Communicate simulation results and recommendations through reports and Presentations.

Course Code	Course Name	Hours per Week			Total Hrs	Total Credits
		L	T	P		
ME3CO39	Machine Design	4	0	0	4	4

COURSE LEARNING OBJECTIVES (CLO_S):

CLO_{01} To understand the fundamental principles of machine design
CLO_{02} To analyze forces and moments acting on machine components and structures.
CLO_{03} To understand the properties of materials commonly used in machine design.
CLO_{04} To select appropriate materials based on mechanical, thermal, and environmental considerations.
CLO_{05} To identify and analyze different machine elements, such as gears, bearings, shafts, and springs.

UNIT I DESIGN AGAINST STATIC & FLUCTUATING LOADS

Types of loads, design under static and fluctuating loads, Stress concentration and its effect on ductile and brittle materials, stress concentration factor for various geometries, cyclic stresses, notch sensitivity, design for finite and infinite life, Soderberg, Goodman & Gerber criteria.

Unit II SHAFTS

Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments.

Unit III DESIGN OF SPUR GEAR

Force analysis of gear tooth, modes of failure, beam strength, Lewis equation, form factor, Gear materials; Surface strength and wear of teeth; strength against wear; Design of straight tooth spur Gears.

Unit IV DESIGN OF BRAKES & CLUTCHES

Various types of Brakes, band brakes. Self-energizing condition of brakes, Design of shoe brakes Internal & external expanding. Design of Clutches, Various types of clutches in use, Design of friction clutches, single disc, multidisc & Centrifugal Torque transmitting capacity.

Unit V JOURNAL BEARING

Types of lubrication, viscosity, hydrodynamic theory, design factors, temperature and viscosity considerations heat dissipation and thermal equilibrium, boundary lubrication, dimensionless numbers, Design of journal bearings, Rolling-element Bearings: Types of rolling contact bearing, bearing friction and power loss, bearing life; Radial, thrust & axial

loads; Static & dynamic load capacities; Selection of ball and roller bearings.

Text Books:

1. J.E.Shigley, Machine Design, TMH
2. V. B.Bhandari, Design of Machine Elments, TMH
3. P.C.Sharma and D.K.Agrawal, Design of Machine Elements, S. K. Kataria & Sons Pub.

Reference Books:

1. Hall and Somani, Machine Design, Schaum Series, TMH
2. A. Mubeen, Machine Design, Khanna Pub.
3. R.Norton, Design Of Machinery, TMH

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO 01 Demonstrate knowledge of materials, stress analysis, and loading conditions.
CO 02 Perform preliminary calculations for mechanical components.
CO 03 Design key machine elements such as shafts, bearings, gears,brakes and clutch.
CO 04 Strategies to prevent failures through proper design considerations.
CO 05 Develop strategies for predictive and preventive maintenance.

Program Elective-IV

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL08	Mechanical Vibrations	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLOs):

CLO 01 To Understand fundamentals of vibrations
CLO 02 To Understand the fundamentals of different types of damping
CLO 03 To analyze the performance of harmonically excited vibrations
CLO 04 To apply the governing equations of multi-degree of freedom systems
CLO 05 To understand the principle of vibration measuring instruments

UNIT I BASICS OF VIBRATION

Basic concepts of vibrations, causes and effects of vibrations. Classification of Vibrations, Vibration parameters- spring, mass, damper. Degree of freedom, static equilibrium position.

UNIT II FREE VIBRATION SYSTEM

Undamped Single Degree of Freedom Vibration System Longitudinal, transverse, torsional vibratory systems. Formulation of differential equations by various principles. Effect of spring inertia on natural frequency. Damped single degree of freedom vibration system Viscous damped system-under damped, critically damped, over damped systems Logarithmic decrement. Coulomb's damping.

Unit III FREE AND FORCED VIBRATION SYSTEM

Free Single Degree of Freedom Vibration System Conversion of multi –springs, multi masses, multi dampers into a single spring mass and damper with linear or rotational co-ordinate system. Forced single degree of freedom vibration system. Analysis of linear and torsional systems subjected to harmonic force and harmonic motion excitation (excluding elastic damper). Force and motion Transmissibility.

UNIT IV VIBRATION MEASURING INSTRUMENTS

Principle of seismic instruments, Vibrometer, accelerometer, sensors used in measurement. Introduction to FFT analyser. Introduction to condition Monitoring and Fault diagnosis.

UNIT V MULTI DEGREE OF FREEDOM VIBRATION SYSTEMS

Lagrange Method, Exact and approximate solution methods.

TEXTBOOKS:

1. G. K. Grover, Mechanical Vibrations, Nem Chand & Bros, Eighth Edition, 2009.
2. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw Hill, 2000.
3. P. L. Ballaney, Theory of Machines, Khanna Publishers, Delhi.
4. S. S. Rao, Mechanical Vibrations, Pearson Education, Fourth edition, 2009.
5. P.Srinivasan, Mechanical Vibration Analysis, Tata McGraw Hill, 1982.
6. Den, Chambil, Hinckle, Mechanical Vibrations.

REFERENCE BOOKS:

1. J.P. Den Hartog, Mechanical Vibrations, McGraw hill Book Company Inc.
2. Leonard Meirovitch, Elements of Vibration Analysis, Tata McGraw Hill, Special Indian Edition, 2007.
3. Grahm Kelly, Mechanical Vibrations, Schaum's outline series, Tata McGraw Hill, Special Edition, 2007.
4. William Seto, Mechanical Vibrations, Schaum's outline series-McGraw Hill.
5. J.S. Rao, K. Gupta, Theory and Practice of mechanical vibrations, New Age International Publication.
6. W.T. Thomson, Theory of vibrations with applications, CBS Publishers, Delhi, 2003.

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO 01 Understand the features of various elements used to model a vibrating body.
CO 02 Form governing equations from a model of a vibrating body.
CO 03 Calculate the stiffness and damping coefficient of the isolation system
CO 04 Understand the principle of vibration measuring instruments
CO 05 Understand various condition monitoring techniques for machines

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL14	Advance Heat Transfer	3	0	0	3	3

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL20	Lean manufacturing	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLO'S)

CLO 01 To understand the principle and concepts of Lean Manufacturing
CLO 02 To explore and understand the various secondary tools used in lean manufacturing
CLO 03 To explore various tools and techniques used in TQM for process improvement
CLO 04 To learn strategies to improve equipment reliability and minimize downtime.
CLO 05 To understand the fundamental principles and concepts of Design of Experiments (DOE)

UNIT I INTRODUCTION LEAN MANUFACTURING

Introduction, Definitions of Lean manufacturing, explaining basic concepts. Overview of historical development. Management theory. 5-S, Workplace organization, Total Productive Maintenance, Process mapping/ Value stream mapping, Work cell.

UNIT II SECONDARY TOOLS OF LEAN MANUFACTURING

Objective and benefits of Secondary lean tool, Cause and Effect diagram, Pareto chart, Poka yoke, Kanban, Automation, Single minute exchange of die (SMED), Design for manufacturing and assembly, Just in time (JIT), Visual workplace, OEE

UNIT III TQM TOOLS AND TECHNIQUES

The seven traditional tools of quality, New management tools, and Six sigma: Concepts, methodology, applications to manufacturing, service sector including IT, Benchmarking, Reason to bench mark, Benchmarking process, FMEA, Stages, and Types. Quality circles ,Quality Function Deployment (QFD), Taguchi quality loss function, TPM ,Concepts, improvement needs, Cost of Quality , Performance measures

UNIT IV TOTAL PRODUCTIVE MAINTENANCE

Objectives and functions, Tero technology, Reliability Centered Maintenance (RCM), maintainability prediction, availability and system effectiveness, maintenance costs, maintenance organization. Minimal repair, maintenance types, balancing PM and breakdown maintenance, Primary and secondary tool for TPM, Case studies related to TPM.

UNIT V DESIGN OF EXPERIMENTS

Introduction , Methods, Taguchi approach, Achieving robust design, Steps in experimental design Designing for Quality: Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA), Concept, Methodology and Application (with case studies). Quality in Service Sectors: Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors.

Text Books:

1. Mitra A., "Fundamentals of Quality Control and Improvement", PHI, 2nd Ed., 1998.
2. J Evans and W Linsay, The Management and Control of Quality, 6'th Edition, Thomson, 2005
3. Liker, Jeffrey K. "The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer McGraw-Hill Education." (2004).
4. Womack, James P., and Daniel T. Jones. *Lean thinking: banish waste and create wealth in your corporation*. Simon and Schuster, 2010.

Reference Books:

1. Besterfield, D H et al., "Total Quality Management", 3rd Edition, Pearson Education, 2008.
2. Narusawa, Toshiko, and John Shook. *Kaizen express: Fundamentals for your lean journey*. Lean Enterprise Institute, 2009.
3. Rother, Mike, and John Shook. Learning to see: value stream mapping to add value and eliminate muda. Lean enterprise institute, 2003.
4. Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia List of Open Source Software/learning website:1. www.nptel.ac.in/

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO 01 Learn the core concepts of Lean manufacturing.

CO 02 Enhance problem-solving skills using secondary tools of lean manufacturing.

CO03 Develop problem-solving skills by applying TQM methodologies in real-world scenarios.

CO 04 Develop problem-solving skills by applying TPM methodologies in real-world scenarios.

CO 05 Develop problem-solving skills by identifying and addressing sources of variation in experiments.

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL26	Smart manufacturing	3	0	0	3	3

Program Elective-V

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL09	Tool Design	3	0	0	3	3

Course Learning Objectives (CLO's):

CLO_{01} To understand the design principles of Jigs and Fixtures for different operations

CLO_{02} To understand the design principles of Press Tools and Dies for sheet working

CLO_{03} To understand the design intricacies of Dies and Punches for Forging process

CLO_{04} To understand the design factors for cutting and mounting elements for single and Multi-point cutting tools

CLO_{05} To understand the principles of Gage design for various applications.

Unit I

Introduction: Tool Design & its objectives, Tool designer's responsibilities, Guidelines of economical tool design

Design of Jigs and Fixtures: Difference between Jigs and fixtures, Principles of Design of Jigs and Fixtures, Design procedure of Jig and Fixture, Principles of Location- Basic principles of location & types of locators, Principles of clamping, Types of Clamping devices, Design of Drill Jigs, Milling fixtures, Turning fixtures.

Unit II

Press Tool Die Design: Introduction to press operations, Presses and their classification, Types of dies- cutting and forming dies, simple, compound and progressive dies, Punching Die Design-calculation of forces on punch and die during piercing, calculation of press power, concept of center of pressure, Blanking Die design- types of dies, calculation of forces on punch and die during blanking Design of drawing Die. Design of Bending Die

Unit III

Design of Forging Die: Drop v/s Press forging, Types of Forging Machines, Types of forging Dies-Open and Closed, Simple and Multi-Impression Dies, Forging design factors, Determination of stock size, Die design for machine Forging, Selection of forging equipments, Manufacture of forging die

Unit-IV

Design of Cutting tools: Introduction to cutting tools, Solid v/s Tipped tools, Parts of cutting tool- cutting element and mounting or clamping element, Design factors for cutting element,

Design factors for mounting element, Design of Single point tool, Design of milling cutters- peripheral and face cutters, Broach Design

Unit-V

Gage Design: Difference between instrument and gage, Classification of gages, Gaging principles, Gauge wear allowance Design of limit gauges- factors to be considered in gauge design- Limit gauge tolerances and Taylor's principle.

Text Books:

1. Sharma P.C. , A text book of Production Engineering, S.Chand and Co., 2009
2. Nee John G. William Dufraine, John W. Evans Mark Hill, Fundamentals of Tool Design, Society of Manufacturing Engineers, Sixth Edition.
3. Jain K.C., Chitle A.K., Text book of Production Engineering, PHI Learning Pvt. Ltd., Second Edition

Reference Books:

1. K. Venkataraman, Design of Jigs, Fixtures and Press Tools, John Wiley and Sons Ltd., First Edition
2. Suchy Ivana, Handbook of Die Design, McGraw Hills, Second Edition

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO01 Students will be able to design the jigs and fixtures for different processes

CO02 Students will be able to evaluate loads for various sheet working operations and design punch and dies accordingly.

CO03 Students will be able to evaluate the forging loads for various components and design punch and die accordingly.

CO04 Students will be able to evaluate cutting loads and design the cutting tools and holding elements for different configurations accordingly.

CO05 Students will be able to assess the measurement requirement and design the gages.

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL15	HVAC	3	0	0	3	3

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL21	Project Management	3	0	0	3	3

Course Learning objectives (CLO's):

CLO_{01} To understand the Fundamentals of Project Management
CLO_{02} To master Network Analysis Techniques
CLO_{03} To develop Skills in Project Duration and Control
CLO_{04} To explore Project Organization and Leadership
CLO_{05} To apply Strategic Planning and Project Appraisal Techniques

Unit I: Concepts of project management: Meaning, definition and characteristics of a project, technical and socio-cultural dimensions; project life cycle phases, project planning and graphic presentation; work breakdown structure, manageable tasks; size of network; blow down NW; identity and logic dummy activity; Fulkerson rule for numbering NW; time-scaled NW

Unit II: NW analysis: PERT network; mean time and variances; probability to complete PERT project in specified time; CPM network; Event Occurrence Time (EOT); activity start/ finish times; forward and reverse path calculations, concept and calculation of floats; resource allocation and critical-chain; overview of MS-project-2000.

Unit III: Project duration and control: Importance and options to accelerate project completion; time cost trade off; fixed variable and total costs; use of floats and cost optimization; project performance measures; project monitoring info and reports; project control process; Gant chart and control chart; cost-schedule S-graph; planned cost of work schedule (PV), budgeted/ earned cost of work completed (EV) and actual cost of work completed (AC); schedule and cost variances (SV, CV) forecasting final project costs.

Unit IV: Project organization, culture and leadership: projects within functional organization; dedicated project/ task-force teams; staff, matrix and network organization; choosing appropriate project organization; Organization culture; ten characteristics; cultural dimensions supportive to projects; social network and management by wandering around (MBWA); different traits of a manager and leader; managing project teams; five stage team development model; shared vision; conflicts; rewards; rejuvenating project teams; project stakeholders; concept of project partnering.

Unit V: Strategic planning and project appraisal: Capital allocation key criteria; Porters competitive strategy model; BCG matrix; Strategic Position Action Evaluation (SPACE); time value of money; cash flows; payback period; IRR; cost of capital; NPV; social cost benefit analysis; UNIDO approach; project risks and financing.

References books:

1. Prasana Chandra: Projects: planning Implementation control; TMH.
2. Gray Clifford F And Larson EW; Project The managerial Process; TMH
3. Panneerselven and Serthil kumar; Project management, PHI
4. Burke; Project Management-Planning and control technics; Wiley India
5. Kamaraju R; Essentials of Project Management; PHI Learning

Textbooks:

1. Jack R. Meredith, Project Management: a managerial approach, Wiley.
2. Choudhary; Project Management; TMH
3. Srinath LS; PERT And CPM Principles and Appl; East West Press
4. Richman L; Project Management: Step by Step; PHI Learning
5. United Nations Industrial Development Organization, Guide to practical project appraisal – social benefit cost analysis in developing countries, oxford & ibh

Course Outcome (CO's):

After completion of this course the students shall be able to:

CO_{01} Define the characteristics of a project and recall the key components of network analysis techniques such as PERT and CPM.
CO_{02} Interpret the significance of critical path analysis in project scheduling.
CO_{03} Apply time-cost trade-off techniques to accelerate project completion and Utilize project performance measures to control schedule and cost.
CO_{04} Analyze different project organizational structures and their suitability.
CO_{05} Construct financial evaluations including NPV, IRR, and payback period for project appraisal.

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
ME3EL27	Machine Learning Techniques	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO 01 To understand pattern classification algorithms to classify multivariate data
CLO 02 To understand the Implementation of genetic algorithms
CLO 03 To gain knowledge about Q-Learning
CLO 04 To create new machine learning techniques
CLO05 To understand the principles of neural networks and deep learning.

UNIT I INTRODUCTION MACHINE LEARNING

What is machine learning; varieties of machine learning, learning input/output functions, sample application. Boolean functions and their classes, CNF, DNF, decision lists. Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods.

UNIT II NEURAL NETWORKS AND GENETIC ALGORITHMS

Neural Network Representation Problems Perceptions Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms Hypothesis Space Search– Genetic Programming – Models of Evolutions and Learning

UNIT III COMPUTATIONAL LEARNING

Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation.

UNIT IV INSTANT BASED LEARNING

Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction.

UNIT V ADVANCED LEARNING

Unsupervised learning, clustering methods based on Euclidean distance and probabilities, hierarchical clustering methods. Introduction to reinforcement and explanation-based learning.

Text Books:

1. Introduction to Machine learning, Nils J.Nilsson
2. Introduction to Machine Learning with Python A guide for data scientists, Andreas, C. Muller & Sarah Guido, O'Reilly
3. Tom M. Mitchell, "Machine Learning", McGraw-Hill, 2010
4. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995

Reference Books:

1. Ethem Alpaydin, (2004) "Introduction to Machine Learning (Adaptive Computation and Machine Learning)", The MIT Press
2. T. Astie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer (2nd ed.), 2009.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO 01 Develop and apply pattern classification algorithms to classify multivariate data.

CO 02 Develop and apply regression algorithms for finding relationships between data variables.

CO 03 Develop and apply reinforcement learning algorithms for learning to control complex systems.

CO 04 Write scientific reports on computational machine learning methods, results and conclusions.

CO05 Develop the skills to apply machine learning techniques to real-world problems.

Open Elective-II

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
OE00085	Innovation and Entrepreneurship	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO_{01} Students will be able to understand the concepts and definitions of innovation.

CLO_{02} Students will be able to understand the importance of innovation and sources of innovation.

CLO_{03} Students will be able to understand the methods of generating ideas and create the business model.

CLO_{04} Students will be able to understand the concept of Blue Ocean Strategy and identify primary and secondary revenue streams.

CLO_{05} Students will be able to understand the concept of positioning and branding.

UNIT I INTRODUCTION TO TECHNOLOGICAL INNOVATION

Basic Concepts and Definitions, Technology, Technology Management, Invention, Innovation, The Concept of Technological Innovation, Innovation Posture, Propensity and Performance, Innovation Measurement, Competitiveness, A Historical and Socio-Technical Perspective on Innovation, Common Frameworks and Typologies, to Characterize Innovations.

UNIT II MANAGING FOR INNOVATION

Key Issues in Innovation Management, Innovation and Competitive Advantage, Types of Innovation, The Importance of Incremental Innovation, Innovation as a Knowledge-based Process, The Challenge of Discontinuous Innovation, Christensen's Disruptive Innovation Theory, Innovation as a Management Process: Innovation as a Core Business Process, Evolving Models of the Process, Consequences of Partial Understanding of the Innovation Process, Successful Innovation and Successful Innovators, Roadmaps for Success, Key Contextual Influences.

UNIT III CREATING AND STARTING THE VENTURE

Sources of new Idea, methods of generating ideas, creative problem solving, opportunity recognition, product planning and development, opportunity recognition. Customer and Solution: Understand who is the customer, who is the consumer, what are the market types, Identify customer segments and niche, Identify jobs, pains, gains, and early adopters, and use them to craft your value proposition, establish your venture's unique value proposition and competitive advantage, Business Model: Basics of Business Model and Lean Approach, Introduction to the Lean Canvas and understand the various components, Sketch a business model for your venture using the Lean Canvas, Identify the riskiest assumptions of your model.

UNIT IV VALIDATION

Refine your value proposition using the Blue Ocean Strategy, Build Solution Demo and conduct Solution Interviews, Fine-tune your canvas based on research and customer feedback, Exploring Ways to Increase Revenue: Understand the cycle of customer acquisition, activation, retention, revenue generation, and referrals to attract new customers, Identify primary and secondary revenue streams, Identify new markets and new customer segments, Explore licensing and franchising options for expansion.

UNIT V MARKETING & SALES:

Positioning and branding – Getting the word out about your new product/service, Identify the channels available to reach your potential customers, Make a Sales Plan using the Funnel approach, Creating a Branding and Channel Strategy: Define a positioning statement, Create a public image and presence for your business, Select a brand name, logo, social media handles, and mobile app names for your venture, Create online public profiles, Select the right channels for your venture using the Bull's-eye Framework.

Text Books:

1. Joe Tidd, John R. Bessant, (2018) Managing Innovation: Integrating Technological, Market and Organizational Change, 6th Edition, Wiley.
2. Ravichandran M. & Prasanna N., (2022), "Innovative Entrepreneurship", Notion Press; 1st edition.
3. Elias G. Carayannis, Elpida T. Samara, Yannis L. Bakouros,(2015). Innovation and Entrepreneurship Theory, Policy and Practice, Springer International Publishing Switzerland.

Reference Books:

1. Martha Corrales-Estrada,(2019) "Innovation and Entrepreneurship: A New Mindset for Emerging Markets", Emerald Publishing Limited.
2. Eric Ries, (2017). "The startup way: how modern companies use entrepreneurial management to transform culture and drive long-term growth", New York: Currency.

3. Matt Ridle, (2020), "How Innovation Works: And Why It Flourishes in Freedom", Harper.

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO_{01} To understand the concepts of and definitions of innovation.

CO_{02} To understand the importance of innovation and sources of innovation.

CO_{03} To understand the methods of generating ideas and create the business model.

CO_{04} To understand the concept of Blue Ocean Strategy and identify primary and secondary revenue streams.

CO_{05} To understand the concept of positioning and branding.

Course Code	Course Name	Hours Per Week			Total Hrs.	Total Credits
		L	T	P		
OE00085	Innovation and Entrepreneurship	3	0	0	3	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO_{01} To understand the concept of Energy Scarcity and its solution using renewa energy.

CLO_{02} To understand working and construction of solar cookers, solar dryers, Sc WHS and solar collectors.

CLO_{03} To understand methods by which wind and geothermal energy can be used.

CLO_{04} To understand various methods of using biomass for energy production a construction of biogas plants.

CLO_{05} To understand Different energy conversion methods of using OTEC and W Energy.

UNIT I INTRODUCTION

Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

UNIT II SOLAR ENERGY

Energy from Sun, Types of Solar Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish , Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Solar Cookers, Solar pond. Solar Cells: Components of Solar Cell System

UNIT III WIND ENERGY

Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. Geothermal Energy: Geothermal Systems, Classifications, Geothermal Resource Utilization Geothermal Based Electric Power Generation, Solid waste and Agricultural Refuse: Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics.

UNIT-IV BIOMASS ENERGY

Biomass Production, Energy Plantation, Biomass Gasification, Updraft and Downdraft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas,

UNIT V OCEAN THERMAL ENERGY

Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Tidal Energy: Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India

Text Books

1. Kothari, Singal & Rajan; Renewable Energy Sources and Emerging Technologies, PHI
2. B.H Khan, Non Conventional Energy, TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection and Storage, TMH.

Reference Books

1. K. Rao, Energy Resources, Conventional & Non-Conventional, BSP Publication.
2. C.S.Solanki, Solar Photovoltaics: Fundamental, technologies and Application, PHI
3. A.Tasneem and SA Abbasi; Renewable Energy Sources; PHI Learning.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Distinguish between various approaches of using solar Energy

CO_{02} Have basic knowledge of construction and working of Solar cookers and solar dryers and develop ability to choose the right device as per requirement.

CO_{03} Basic understanding of construction and working of different types of solar collectors and analysis their characteristics, merits and demerits

CO_{04} Analyze and Understand construction and working of different types of solar water heating systems

CO_{05} Elementary knowledge of design and working of photovoltaic technology and equipment related to it.

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
ME3PC11	Mini Project	0	0	4	4

1. Mini Project can be an individual or a group activity depending on the depth and scope of the topic.
2. The project work can be any of the form given below :

a) Making physical working models, prototypes, scaled models, of a concept machine.
b) Making virtual / CAD models of a sufficiently complex machines / concepts.
c) Making study, modeling, analysis, programming and simulation of a system / machine /operation / process.
d) Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.

3. Group formation, discussion with faculty advisor, formation of the Semester Mini Project statement, resource requirement, if any should be carried out in the earlier part of the semester.
4. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.
5. A complete Assembly and Details drawings of the project should be submitted along with a Detailed project report, where applicable.
6. A Detailed Background / field / literature survey, related to the topic must be made and presented in the report.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3NG08	Soft Skills-IV	2	0	0	2

SEMESTER – VII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3ELXX	Program Elective - VI	3	0	0	3
3		Open Elevtive III	3	0	0	3
4	ME3PC12	Project-1	0	0	8	4
	ME3PC03	Industrial Training	0	2	0	2
5	EN3NG06	Open Learning Courses	1	0	0	1
		Total	**7**	**2**	**8**	**13**
		Total Contact Hours	**17**			

Program Elective-VI

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3EL10	Product Design & Development	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO 01 To develop an understanding of basics of product design and development.
CLO 02 To develop an understanding of product design from a customer perspective.
CLO 03 To understand the role of creative thinking and other methods in product design
CLO 04 To understand the material selection process based on performance cost requirements.
CLO 05 To understand the aspects of industrial design and evaluation of costs

UNIT- I PRODUCT DESIGN FUNDAMENTALS

Definition & importance of engineering design, types of design , the design process-conceptual, embodiment and detailed design, Essential factor of product design, relevance of product life cycle, designing to codes and standards, societal considerations in engineering design, generic product development process, morphology of design- seven phases of product development

UNIT – II CUSTOMER ORIENTED DESIGN

Identification of customer needs- customer requirements and its classification, establishing engineering characteristics, enabling Quality Function Deployment, Product Strategies-pricing, quality, aesthetics and utility, Product Analysis- marketing, product characteristics,economic and production aspects, Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.legal and Ethical issues in design- contracts and liability, Product liability – Protecting intellectual property, Codes of ethics.

UNIT- III DESIGN METHODS

Creative Thinking, Creativity and problem solving, creative thinking methods, generating design concepts - Creative methods for designing–functional decomposition – physical decomposition – functional representation – morphological methods-TRIZ- axiomatic design. Decision making theory- utility theory –decision trees –concept evaluation methods.

UNIT – IV MATERIAL SELECTION FOR DESIGN

Design process and material selection, Performance characteristics of materials, Material Selection Process in embodiment and conceptual design – Economics of materials- Cost and its structure – Material performance Index, Material Selection with Decision Matrices, Recycling and material selection, Design for brittle fracture, design for fatigue failure, design for corrosion resistance and design against wear.

UNIT- V INDUSTRIAL DESIGN

Industrial design and assessing its need, impact of industrial design, industrial design process & its management, Assessing quality of industrial design, different aspects of design- design for manufacturing, design for serviceability, design for environment, design for cost, design for safety and reliability, cost evaluation, categories of cost –overhead costs – activity based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing

Text Books

1. Engineering Design, George E.Dieter and Linda C. Schmidt**,** McGraw Hill Education(I) Pvt Ltd., Fourth Edition.
2. Product Development, by Chitale & Gupta, PHI, Fifth Edition.
3. Product Design and Development, K.T. Ulrich and S.D. Eppinger, McGraw Hill, Fifth Edition
4. Product Design, Kevin Otto, Kristin wood, Pearson Education Inc., Ist Edition

Reference Books

1. The Mechanical Process Design, David G. Ullman, McGraw Hill,
2. Engineering Design Process, by Yousef Haik, Tamer Shahin, Cengage Learning,First Edition
3. Product Design & Process Engineering,Benjamin W. Niebel and, Alan B. Draper, McGraw Hill Inc., First Edition
4. Value Management, Edward D. Heller, Addison- Wesley Publishing Company,First Edition

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Use life cycle concepts and societal constraints in designing products.
CO_{02} Incorporates customer inputs to designing and ensuring quality of product.
CO_{03} Implement creative thinking to design the product design.
CO_{04} Select proper material based on cost, properties and decision matrices.
CO_{05} Develop industrial design considering various aspects of performance.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3EL16	Energy Management	3	0	0	3

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3EL22	Industrial Revolution 4.0	3	0	0	3

Course Learning Objectives (CLO's):

CLO_{01} To comprehend the fundamental concepts and principles of Industrial revolution 4.0.

CLO_{02} To explore the integration of robotics and automation with advanced technologies in the context of Industrial revolution 4.0.

CLO_{03} To understand the role of cyber-physical systems, IoT, and cloud computing in Industrial revolution 4.0.

CLO_{04} To understand the role of digital twin and cyber security in Industrial revolution 4.0.

CLO_{05} To analyze and evaluate the impact of Industrial revolution 4.0on industrial sectors and future trends.

Unit 1: Introduction to Industrial revolution 4.0

Evolution of industrial revolutions: From Industry 1.0 to Industry 4.0, Key concepts and principles of Industry 4.0, Smart factories and cyber-physical systems , Impact of Industry 4.0 on robotics and automation

Unit 2: Advanced Technologies in Industrial revolution 4.0

Internet of Things (IoT) and its applications in industrial settings, Cloud computing and its role in Industry 4.0, Big data analytics for smart manufacturing , Artificial Intelligence and machine learning in Industry 4.0

Unit 3: Robotics and Automation in Industrial revolution 4.0

Collaborative robotics and human-robot interaction, Industrial automation systems and control, Sensing and perception technologies in smart factories, Robotic process automation (RPA) and intelligent automation

Unit 4: Digital Twin and Cybersecurity in Industrial revolution 4.0

Digital Twin technology and its applications, Virtual and augmented reality in manufacturing, Data security and privacy in Industry 4.0, Cybersecurity challenges and solutions in smart factories

Unit 5: Applications and Future Trends in Industrial revolution 4.0

Smart logistics and supply chain management, Predictive maintenance and condition monitoring, Smart energy management and sustainable manufacturing.

Textbooks:

1. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist
2. "Robotics and Automation in the Industry 4.0 Era" by Pedro Neto and Anibal Reñones.

Reference Books:

1. "Digital Twin Technologies and Smart Cities" by QuangVinh Nguyen et al.
2. "Smart Manufacturing: Innovation and Transformation" by Hui-Ming Wee and Kuan Yew Wong

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO_{01} Understand the concepts of all technologies used to support industry 4.0 environments.

CO_{02} Understand the role and application of cyber-physical systems, the Internet of Things (IoT), cloud computing, and big data analytics, Digital twin and cyber security in Industry 4.0.

CO_{03} Apply the knowledge of AI, ML, IOT, could computing, CPS, Big data, Robots, sensors and cyber security to design and implement solutions within the context of Industry 4.0.

CO_{04} Explore applications and challenges of Industry 4.0 in areas such as smart logistics, supply chain management, predictive maintenance, condition monitoring, smart energy management, sustainable manufacturing, digital twin and cyber security.

CO_{05} Analyze and evaluate the impact of Industry 4.0 on Automotive sector, and identify future trends in the field.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3EL28	Manufacturing Analytics	3	0	0	3

Open Elective-III

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00047	Open Elective-III Advanced Machining Process	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} To develop the ability to understand the need of modern machining processes and their classification and the mechanical type advanced machining processes

CLO_{02} To be able to understand the various Chemical and Electrochemical Type Advanced Machining Processes

CLO_{03} To understand Thermal Type Advanced Machining Processes

CLO_{04} To understand various Hybrid Advanced Machining Processes

CLO_{05} To understand different types of Hybrids Finishing Processes.

Unit I

Mechanical Type Processes : Limitations of conventional machining process, classification of advanced machining processes, **Classification of mechanical type processes** : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - abrasive jet machining (AJM), ultrasonic machining (USM), water jet machining (WJM), recent developments in all the processes.

Unit II

Chemical and Electrochemical Type Processes : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - chemical machining (CHM), maskants and its type, methods of applying maskants, Electrochemical machining[ECM], electrolyte flow design in ECM.

Unit III

Thermal Processes : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - electric discharge machining(EDM), different circuits of pulsating dc supply, wire-cut EDM, transferred and non-transferred arc type plasma arc machining (PAM), Electron beam machining(EBM) and Laser Beam machining (LBM).

Unit IV

Hybrid Processes: Principle and mechanics of metal removal, advantages, disadvantages and limitations of – abrasive electro-discharge machining (AEDM), ultra sonic assisted EDM (EDMUS), laser assisted ECM (ECML) ,ultra sonic assisted ECM (USECM)

Unit V

Hybrid Finishing Processes: Working principle, applications, advantages and limitations of - electrochemical grinding (ECG), electro-discharge grinding (EDG), electrochemical de-burring (ECD), electrochemical honing (ECH), magnetic abrasive finishing (MAF),

Text Books:

1. P.C. Pandey and H.S.Shan, "Modern Machining processes", McGraw Hill Education
2. M.K.Singh, "Unconventional Manufacturing Processes" New Age International
3. Hassan Abdel-Gawad El-Hofy, "Advanced Machining processes", McGraw Hill

Reference Books:

1. G.F. Benedict, Marcel Dekker,Nontraditional Manufacturing Processes", Inc. New York.
2. Vijay.K. Jain, "Advanced Machining Processes" Allied Publishers.
3. Amitabha Ghosh and Asok Kumar Mallick, "Manufacturing Science", East West Press.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand the need of modern machining processes and their classification and various types of advance machining processes.

CO_{02} Understand the various mechanical type, Chemical and Electrochemical type, Thermal Type Advance Machining Processes

CO_{03} Understand the various Hybrid Advance Machining Processes and Hybrid Finishing Processes

CO_{04} Analyze the role of the various Advance Machining Processes in Industries

CO_{05} Apply the knowledge of Advance Machining Process to do the machining of modern strong alloys

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00084	Open Elective-III Start-up Creation through Experimental Learning	3	0	0	3

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00048	Open Elective-III Supply Chain Management	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} Define and formulate linear programming problems and appreciate their limitations.

CLO_{02} Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.

CLO_{03} Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.

CLO_{04} Develop mathematical skills to analyse and solve integer programming and network models arising from a wide range of applications.

CLO_{05} Develop mathematical skills to analyse and solve inventory models arising from a wide range of applications.

Unit I

Introduction &Building a Strategic Framework to Analyze Supply Chains: An Introduction, Strategic view of supply chains, Evolution of Supply Chain Management (SCM), Importance of the supply chain, Decision phases in a supply chain, Process views of supply chain, Enablers of supply chain performance, Supply chain strategy and performance measures–competitive and supply chain strategies – Achieving strategic fit, managing material flow in supply chain

Unit II

Designing the Supply Chain Network: Designing distribution networks and applications to e-business, network design in the supply chain, network designing an uncertain environment, supply chain planning, supply chain coordination, decision modeling for supply chain, green supply chain

Unit III

Supply Chain Distribution and Integration and Risk Pooling : Supply chain integration, Warehouse Management Systems, Storage Systems, Material Handling Requirements, Distribution Strategies – Traditional Retail, Direct Shipping, Cross-docking, Cross-dock Operations, Distribution Strategies: Pool Distribution, Trans shipment, Milk-Run Systems, Classic Techniques of Risk Management, Pooling based on Location, Product, lead Time and capacity.

Unit IV

Supplier Relationship Management: Integrating Suppliers into the e-Value Chain : Defining Purchasing and Supplier Relationship Management, Components of SRM, The Internet-Driven SRM Environment, e-SRM Structural Overview, e-SRM Services Functions, e-SRM Processing, e-SRM Technology Services, Anatomy of The e-SRM Marketplace Exchange Environment, Implementing e-SRM

Unit V

Transportation and Packaging : Transportation – Drivers, Modes, Measures - Strategies for Transportation, 3PL and 4PL, Vehicle Routing and Scheduling. Packaging- Design considerations, Material and Cost. Packaging as Unitisation. Consumer and Industrial Packaging.

Text Books:

1. Ronald H. Ballou and Samir K. Srivastava, Business Logistics and Supply Chain Management, Pearson education
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education
3. Mohanty R.P and Deshmukh S.G, Supply chain theories and practices, Biztantra publications.

Reference Books:

1. Bowersox Donald J, Logistics Management – The Integrated Supply Chain Process,Tata McGraw Hill
2. Vinod V. Sople, Logistics Management-The Supply Chain Imperative, Pearson.
3. Coyle et al., The Management of Business Logistics, Thomson Learning

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Become familiar with current supply chain management trends Understand and apply the current supply chain theories, practices and concepts utilizing case problems and problem-based learning situations

CO_{02} Formulate and implement Warehouse Best Practices and Strategies

CO_{03} Plan Warehouse and Logistics operations for optimum utilization of resources

CO_{04} Identify and Analyse Business Models, Business Strategies and, corresponding Competitive Advantage.

CO_{05}	Develop and utilize critical management skills such as negotiating, working effectively within a diverse business environment, ethical decision making and use of information technology

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
ME3PC12	Project-I	0	0	8	4

1. Project-I can be an individual or a group activity depending on the depth and scope of the topic.
2. The project work can be any of the form given below:

a) Making physical working models, prototypes, and scaled models of a concept machine.
b) Making virtual / CAD models of a sufficiently complex machines / concepts.
c) Making study, modeling, analysis, programming and simulation of a system / machine /operation / process.
d) Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.

3. Group formation, discussion with faculty advisor, formation of the Semester Mini Project statement, resource requirement, if any should be carried out in the earlier part of the semester.
4. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.
5. A complete Assembly and Details drawings of the project should be submitted along with a Detailed project report, where applicable.
6. A Detailed Background / field / literature survey, related to the topic must be made and presented in the report.

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
ME3PC03	Industrial Training	0	2	0	2

Industrial Training is a structured program that integrates academic learning with practical industrial experience. It is designed to bridge the gap between theoretical knowledge gained in the classroom and real-world applications in the industry. This program is essential for students in engineering, technology, and related fields as it provides hands-on experience and exposure to actual working environments.

Objectives of Industrial Training:

1. **Skill Development:** Enhance practical skills and technical knowledge that are crucial for industry-specific tasks.
2. **Workplace Experience:** Provide firsthand experience of the professional work environment, including workplace culture, practices, and expectations.
3. **Application of Knowledge:** Enable students to apply academic concepts and theories to real-world industrial problems and projects.
4. **Professional Networking:** Offer opportunities to build connections with industry professionals, which can be valuable for future career prospects.
5. **Career Insight:** Help students gain insights into potential career paths and make informed decisions about their professional future.

Key Components of Industrial Training:

1. **Orientation:** Introduction to the company, its operations, safety protocols, and expectations during the training period.
2. **Hands-on Projects:** Participation in live projects and tasks relevant to the student's field of study, under the guidance of experienced professionals.
3. **Mentorship:** Regular interaction with mentors and supervisors who provide guidance, feedback, and support throughout the training.
4. **Evaluation:** Continuous assessment of the student's performance through reports, presentations, and evaluations by industry mentors.
5. **Reflection:** Opportunities for students to reflect on their experiences, challenges faced, and lessons learned during the training.

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
EN3NG06	Open learning Courses	1	0	0	1

Open Learning Courses are educational programs designed to be accessible to a broad audience, often offered online and available to anyone with an internet connection. These courses aim to make education more inclusive and flexible, allowing learners to study at their own pace and according to their own schedules.

Objectives of Open Learning Courses:

1. **Accessibility:** Provide educational opportunities to learners regardless of their geographical location, financial situation, or prior educational background.
2. **Flexibility:** Allow learners to study at their own pace and on their own schedule, accommodating diverse learning styles and life commitments.
3. **Lifelong Learning:** Encourage continuous personal and professional development by providing access to a wide range of subjects and skill sets.
4. **Inclusivity:** Promote equal access to high-quality education for all, reducing barriers related to cost, location, and time.

SEMESTER VIII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	ME3PC14	Major Project	0	0	24	12
		Total	**0**	**0**	**24**	**12**
		Total Contact Hours	**24**			

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
ME3PC14	Project-II	0	0	24	24

1. Project-II can be an individual or a group activity depending on the depth and scope of the topic.
2. The project work can be any of the form given below:

a) Making physical working models, prototypes, and scaled models of a concept machine.
b) Making virtual / CAD models of a sufficiently complex machines / concepts.
c) Making study, modeling, analysis, programming and simulation of a system / machine /operation / process.
d) Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.

3. Group formation, discussion with faculty advisor, formation of the Semester Mini Project statement, resource requirement, if any should be carried out in the earlier part of the semester.
4. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.
5. A complete Assembly and Details drawings of the project should be submitted along with a Detailed project report, where applicable.
6. A Detailed Background / field / literature survey, related to the topic must be made and presented in the report.