Paper Code(s): ES-201	**L**	**P**	**C**
Paper: Computational Methods	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand numerical methods to find roots of functions and first order unconstrained minimization of functions.
2.	To introduce concept of interpolation methods and numerical integration.
3.	To understand numerical methods to solve systems of algebraic equations and curve fitting by splines.
4.	To understand numerical methods for the solution of Ordinary and partial differential equations.

Course Outcomes (CO)

CO 1	Ability to develop mathematical models of low level engineering problems
CO 2	Ability to apply interpolation methods and numerical integration.
CO 3	Ability to solve simultaneous linear equations and curve fitting by splines
CO 4	Ability to numerically solve ordinary differential equations that are initial value or boundary value problems

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	2	-	-	-	2	2	2	3
CO 2	3	2	2	2	2	-	-	-	2	2	2	3
CO 3	3	3	3	3	2	-	-	-	2	2	2	3
CO 4	3	3	3	3	2	-	-	-	2	2	2	3

UNIT-I

Review of Taylor Series, Rolle 's Theorem and Mean Value Theorem, Approximations and Errors in numerical computations, Data representation and computer arithmetic, Loss of significance in computation
Location of roots of equation: Bisection method (convergence analysis and implementation), Newton Method (convergence analysis and implementation), Secant Method (convergence analysis and implementation). Unconstrained one variable function minimization by Fibonacci search, Golden Section Search and Newton's method. Multivariate function minimization by the method of steepest descent, Nelder- Mead Algorithm.

UNIT-II

Interpolation: Assumptions for interpolation, errors in polynomial interpolation, Finite differences, Gregory-Newton's Forward Interpolation, Gregory-Newton's backward Interpolation, Lagrange's Interpolation, Newton's divided difference interpolation
Numerical Integration: Definite Integral, Newton-Cote's Quadrature formula, Trapezoidal Rule, Simpson's one-third rule, simpson's three-eight rule, Errors in quadrature formulae, Romberg's Algorithm, Gaussian Quadrature formula.

UNIT-III

System of Linear Algebraic Equations: Existence of solution, Gauss elimination method and its computational effort, concept of Pivoting, Gauss Jordan method and its computational effort, Triangular Matrix factorization methods: Dolittle algorithm, Crout's Algorithm, Cholesky method, Eigen value problem: Power method Approximation by Spline Function: First-Degree and second degree Splines, Natural Cubic Splines, B Splines, Interpolation and Approximation

UNIT - IV

Numerical solution of ordinary Differential Equations: Picard's method, Taylor series method, Euler's and Runge-Kutta's methods, Predictor-corrector methods: Euler's method, Adams-Bashforth method, Milne's method.
Numerical Solution of Partial Differential equations: Parabolic, Hyperbolic, and elliptic equations
Implementation to be done in C/C++

Textbook(s):
1. E. Ward Cheney & David R. Kincaid , "Numerical Mathematics and Computing" Cengage; 7th ed (2013).

References:
1. R. L. Burden and J. D. Faires, "Numerical Analysis", CENGAGE Learning Custom Publishing; 10th Edition (2015).
2. S. D. Conte and C. de Boor, "Elementary Numerical Analysis: An Algorithmic Approach", McGraw Hill, 3rd ed. (2005).
3. H. M. Antia, "Numerical Methods for Scientists & Engineers", Hindustan Book Agency, (2002).
4. E Balagurusamy "Numerical Methods" McGraw Hill Education (2017).

Paper Code(s): ES-251	**L**	**P**	**C**
Paper: Computational Methods Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Computational Methods) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

Implementation to be done in C/C++

1. Program for finding roots of f(x)=0 Newton Raphson method.
2. Program for finding roots of f(x)=0 by bisection method.
3. Program for finding roots of f(x)=0 by secant method.
4. To implement Langrange's Interpolation formula.
5. To implement Newton's Divided Difference formula.
6. Program for solving numerical integration by Trapezoidal rule
7. Program for solving numerical integration by Simpson's 1/3 rule
8. To implement Numerical Integration Simpson 3/8 rule.
9. Inverse of a system of linear equations using Gauss-Jordan method.
10. Find the Eigen values using Power method.
11. Program for solving ordinary differential equation by Runge-Kutta Method.

Paper Code(s): HS-203	**L**	**P**	**C**
Paper: Indian Knowledge System	**2**	**-**	**2**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks
3. This is an NUES paper, hence all examinations to be conducted by the concerned teacher.

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the Indian knowledge System.
2.	To understand the foundational concepts for science and technology.
3.	To understand the ancient Indian mathematics and astronomy.
4.	To understand the ancient Indian engineering and technology.

Course Outcomes (CO)

CO 1	Ability to understand the Indian knowledge System.
CO 2	Ability to understand and apply foundational concepts for science and technology.
CO 3	Ability to understand and apply ancient Indian mathematics and astronomy
CO 4	Ability to understand ancient Indian engineering and technology.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	-	-	-	-	-	3	-	-	-	-	-	2
CO 2	-	-	-	-	-	3	-	-	-	2	-	2
CO 3	3	3	-	-	-	-	-	-	-	-	-	2
CO 4	3	3	-	-	-	-	-	-	-	-	-	2

UNIT-I

Indian Knowledge System (IKS) - An Introduction:
Overview of IKS - Importance of Ancient Knowledge; Defining IKS; The IKS Corpus – A Classification Framework; Chaturdaśa-Vidyāsthāna; History of IKS, Some unique aspects of IKS;
The Vedic Corpus – Introduction to Vedas; The Four Vedas and their divisions; Vedāngas; Vedic Life;
Philosophical Systems – Indian Philosophical Systems; Vedic Schools of Philosophy; Non-Vedic Philosophical Systems; Wisdom through the Ages – Purānas, Itihāsa as source of wisdom, Rāmāyana, Mahābhārata, Niti-śāstras, Subhāssitas.

UNIT-II

Foundational Concepts for Science and Technology:
Linguistics - Components of Language; Pānini's work on Sanskrit Grammar; Phonetics in Sanskrit; Patterns in Sanskrit Vocabulary; Computational Concepts in Astādhyāyi, Logic for Sentence Construction; Importance of Verbs; Role of Sanskrit in Natural Language Processing

Number System and Units of Measurement – Number System in India; Salient Features of the Indian Numeral System; Unique approaches to represent numbers; Measurements for Time, Distance and Weight; Pingala and the Binary System
Knowledge: Framework and Classification – The Knowledge Triangle; Prameya; Pramāna; Samśaya; Framework for establishing Valid Knowledge

UNIT-III

Mathematic and Astronomy in IKS:
Mathematics – Unique aspects of Indian Mathematics; Great Mathematicians and their Contributions; Arithmetic; Geometry; Trigonometry; Algebra; Binary Mathematics and Combinatorial Problems in Chandah-śāstra of Pingala, Magic Squares in India
Astronomy - Unique aspects of Indian Astronomy; Historical Development of Astronomy in India; The Celestial Coordinate System; Elements of the Indian Calendar; Āryabhatiya and the Siddhāntic Tradition; Pancānga; Astronomical Instruments; Jantar Mantar of Rājā Jai Singh Sawai

UNIT - IV

Engineering and Technology in IKS:
Engineering and Technology: Metals and Metalworking – The Indian S & T Heritage; Mining and Ore Extraction; Metals and Metalworking Technology; Iron and Steel in India; Lost wax casting of Idols and Artefacts; Apparatuses used for Extraction of Metallic Components
Engineering and Technology: Other Applications – Literary sources for Science and Technology; Physical Structures in India; Irrigation and Water Management; Dyes and Painting Technology; Surgical Techniques; Shipbuilding; Sixty-four Art Forums; Status of Indigenous S & T

Textbook(s):
1. B. Mahadevan, Vinayaka Rajat Bhat & Nagendra Pavana R.N., "Introduction to Knowledge System: Concepts and Applications" PHI (2022).

References:
1. C.M Neelakandhan & K.A. Ravindran, "Vedic Texts and The Knowledge Systems of India", Sri Sankaracharya University of Sanskrit, Kalady (2010).
2. P.P. Divakaran, "The Mathematics of India: Concepts, Methods, Connections", Springer (2018)
3. C.A. Sharma, "Critical Survey of Indian Philosophy", Motilal Banarasidass Publication (1964)
4. G. Huet, A. Kulkarni & P. Scharf, "Sanskrit Computational Linguistics", Springer (2009).
5. A.K. Bag, "History of Technology in India", Indian National Science Academy, Vol 1, (1997)

Paper Code(s): MEC-205	**L**	**P**	**C**
Paper: Theory of Machines	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To impart knowledge of various types of mechanisms and perform their synthesis by analytical and graphical method.
2.	To develop the understanding of Gears, Gear trains and Gyroscope.
3.	To facilitate students to understand the function and working of flywheels and governor.
4.	To learn and study the phenomena of balancing and mechanical vibrations.

Course Outcomes (CO)

CO 1	Examine various types of mechanisms and execute their kinematic analysis.
CO 2	Explain the concept of Gears, Gear Trains and Gyroscope.
CO 3	Describe the working principle of flywheel and governor.
CO 4	Understand the concept of balancing and mechanical vibration system.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	3	3	3	-	2	-	-	-	-	-	2
CO 2	3	3	3	3	-	2	-	-	-	-	-	2
CO 3	3	3	3	3	-	2	-	-	-	-	-	2
CO 4	3	3	3	3	-	2	-	-	-	-	-	2

UNIT-I

Mechanisms And Machines: Introduction of Simple mechanism, Different types of Kinematics pair, Grubler's rule for degree of freedom, Grashof's Criterion for mobility determination, Inversions of 4R, 3R-P, and 2R-2P chains. Kinematic Analysis of Planar Mechanisms: Velocity and acceleration diagrams, Application of relative velocity method in Slider crank and four bar mechanism, Instantaneous centre method, Kennedy-Arnold theorem, Acceleration diagrams for simple mechanism.

Cams: Classification, Construction of Cam profile, Analysis of Cams with uniform acceleration, and retardation, SHM, Cycloidal motion.

UNIT-II

Gears and Gear Trains: Classification of gears, Terminology, Geometry of tooth profiles, Law of gearing, Cycloidal and Involute profile, Undercutting and interference, Methods to avoid interference, Condition for minimum number of teeth to avoid interference, Contact ratio, Interference, Simple, Compound and Epicyclic gear trains, Tabular column method for Epicyclic gear trains, Fixing torque.

Gyroscopes: Principles of Gyroscope, Effect of Gyroscopic couple on automobiles, ships and aircrafts.

UNIT-III

Dynamic Analysis: Analysis of single slider crank mechanism for displacement, velocity and acceleration using analytical method, Klein's Construction, Turning moment diagrams, Flywheel.
Mechanical governors:Function of a governor, types of governors: weight and spring loaded, Hunting and Sensitivity, efforts and power of a governor, controlling diagrams.

UNIT - IV

Balancing: Static and Dynamic balancing, balancing of rotating and reciprocating masses, single and multicylinder engines.
Vibrations: Free vibration of a body, single degree of freedom system, Rayleigh method, free vibrations with viscous damping, Logarithmic decrement, Response of damped spring mass system to harmonic forces, Whirling of shafts, Vibration isolation, Transmissibility Ratio.

Textbook(s):
1. S.S. Rattan, "Theory of Machines", Tata McGraw Hill.
2. V.P. Singh, "Theory of Machines", Dhanpat Rai & Co.(P)Ltd.

References:
1. J E Shigley "Theory of Machines", Pearson.
2. Thomas Beven, "The Theory of Machines", CBS Publishers.
3. R.L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill.
4. P.L. Ballaney, "Theory of Machines & Mechanism", Khanna Publishers.

Paper Code(s): MEC-207	**L**	**P**	**C**
Paper: Strength of Materials	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand about different types of load conditions and determine the stress, strain and change in geometrical parameters of different types of materials.
2.	To understand the resistance mechanism of beams due to bending and shearing.
3.	To understand the principal stresses, behaviour of torsional members, columns and failure mechanisms in materials.
4.	To understand the difference between thin & thick pressure vessels and the design of springs.

Course Outcomes (CO)

CO 1	Evaluate the stress induced in structural members subjected to tension, compression, tangential and thermal loads.
CO 2	Analyse the performance of the beam for different types of loads and support conditions using SFD and BMD and determine the bending stress, shear stress and deflection induced.
CO 3	Analyse the stress induced in columns and members under torsion.
CO 4	Distinguish between thin and thick pressure vessels and estimate the different stresses induced in pressure vessels and springs.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	3	3	3	-	2	-	-	-	-	-	2
CO 2	3	3	3	3	-	3	-	-	-	-	-	2
CO 3	3	3	3	3	-	3	-	-	-	-	-	2
CO 4	3	3	3	2	-	3	-	-	--	-	-	2

UNIT-I

Simple Stresses & strains: Concept of stress and strain. Hooke's law, Stress-Strain diagram, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Elongation due to self-weight. Saint Venant's principle, Compound bars, state of simple shear, complementary shear stress, Volumetric stresses and Strains, Elastic constants and their relationship, Thermal stresses, Compound section subjected to thermal stresses, Sudden, gradual & impact load, Strain energy & Proof Resilience, Strain energy under normal and shear stress.

UNIT-II

Shear Force and Bending Moment in Beams: Types of beams, supports and loadings, Definition of bending moment and shear force, Sign conventions, relationship between load intensity, Bending moment and shear

force, Shear force and bending moment diagrams for statically determinate beams subjected to points load, Uniformly distributed loads, Uniformly varying loads, Couple and their combinations.

Bending and Shear Stresses in Beams: Introduction, Pure bending theory, Assumptions, Derivation of bending equation, Modulus of rupture, Section modulus, Flexural rigidity, Beam of uniform strength, Expression for transverse shear stress in beams, Bending and shear stress distribution diagrams for circular, rectangular, 'I', and 'T' sections, Castigliano's theorem, Shear Centre (only concept).

Slope and deflection of Beams: Definition of slope, Deflection and curvature, Sign conventions, Derivation of moment curvature equation, Double integration method, Macaulay's method and Principle of superposition method, Slope and deflection for standard loading cases and for determinate prismatic beams subjected to point loads, UDL, UVL and couple. [12]

UNIT-III

Columns: Introduction, Short, Medium and Long columns, Slenderness ratio, Euler's theory; Assumptions, Derivation for Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine-Gordon's formula for columns.

Torsion: Stresses and strains in pure torsion of solid circular shafts and hollow circular shafts, Power transmitted by shafts, Shaft in series and parallel, Combined bending and torsion.

Compound stresses and strains: State of stress at a point, General two-dimensional stress system, Principal stresses and strains, Principal planes. Mohr's circle of stresses, Theories of Failures.

UNIT - IV

Springs: Analysis of Close-coiled helical springs, Springs in series and parallel, Stress in leaf springs.

Pressure vessels: Thin cylindrical and Spherical vessels subjected to internal pressure, Hoop stresses, Longitudinal stress and change in volume, Thick cylinders subjected to internal and external pressure, Lame's equation, Radial and hoop stress distribution.

Textbook(s):

1. Sadhu Singh, "Strength of Materials", Khanna Pub.
2. S.S. Bhavikatti, "Strength of Materials", Vikas Publishers;(2000)
3. R.K. Bansal, "A Textbook of Strength of Materials", Laxmi Publications; 4th ed.(2010)

References:

1. S.P. Timoshenko and J. Gere, "Elements of Strength of Materials", East-West affiliated, New Delhi.
2. R.C. Hibbler, "Mechanics of Materials", Prentice Hall, New Delhi;(1994)
3. L.S. Sri Nath et.al., "Strength of Materials", McMillan, New Delhi;(2001)
4. Eger P. Popov, "Engg. Mechanics of solids", Prentice Hall, New Delhi;(1998)
5. Roger T. Fenner, "Mechanics of Solids", U.K. B.C. Publication, New Delhi;(1990)

Paper Code(s): MEC-209	**L**	**P**	**C**
Paper: Manufacturing Science & Technology - I	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To acquire knowledge in casting processes and develop an understanding of the various variables which control the casting process.
2.	To introduce students to different welding processes, weld testing and advanced processes.
3.	To acquire a fundamental knowledge on metal forming technology.
4.	To make student familiar with the various sheet metal work and powder metallurgy.

Course Outcomes (CO)

CO 1	Understand the working of different manufacturing processes and apply knowledge to use appropriate manufacturing process based on the need.
CO 2	Identify the capabilities of the different manufacturing processes.
CO 3	Analyse the different design aspects of the manufacturing processes
CO 4	Evaluate the effects of process parameters on the performance of Manufacturing processes and prepare a report in a team for different processes.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	-	-	2	-	-	-	-	-	-
CO 2	3	2	2	-	-	2	-	-	-	-	-	-
CO 3	3	3	3	2	-	2	-	-	-	-	-	-
CO 4	3	3	3	3	-	2	-	-	3	3	-	-

UNIT-I

Casting: Introduction to sand moulding, Testing of moulding sand, Moulding and core making machine, Design of metal moulds, Gating system and its design, Riser design and its placement, Mould filling time, Melting, Pouring and Fluidity, Selection of melting furnaces, Control of melt and Cupola charge calculations, Solidification of pure metals and alloys, Solidification time, Fundamentals of Casting of complicated shapes: automotive components, casting of light alloys – Aluminium, Magnesium and Titanium alloys and Other casting processes, like investment, continuous, slush, squeeze casting, stir casting.

UNIT-II

Welding: Types of metal transfer in arc welding, Analysis of Voltage-Arc length Characteristics, Welding processes like GTAW, GMAW and SAW processes and their recent variants, Plasma arc welding process: transferred and non- transferred arc welding and their applications, Plasma cutting, Surfacing and plasma spray forming, Explosive, Ultrasonic, Laser Beam, Electron Beam, Friction Stir, Thermit, Atomic Hydrogen welding, Cold metal

transfer Welding, Resistance welding, Soldering and brazing, welding of special materials – Stainless steel, Aluminium etc. weldability of cast iron, steel, stainless steel, aluminium alloys, Soldering, Brazing and their applications, Joint design, welding symbols and Joint evaluation through destructive and non-destructive testing methods, Defects in welding: causes and remedies, Related numerical problems on electric arc welding and resistance welding.

UNIT-III

Forming: Plastic deformation of metals, Elements of theory of plasticity, Flow curve, True stress & true strain, stress-strain relationships, Yield criteria for ductile metals, Von Misses & Teresa yield criteria, combined stress tests, Hot working and Cold working, Friction and lubrication in metal working, Analysis of bulk forming Process: Extrusion: Analysis of extrusion process, extrusion pressure, Rolling: Forces & geometrical relationship in rolling, Rolling load and torque in cold rolling, Von-Karman work equation, Wire and Tube Drawing, Drawing stress, Reduction factor, Unconventional forming processes, Defects in metal forming.

UNIT - IV

Sheet Metal and other Processes: Classification - conventional and HERF processes-presses-types and selection of presses, formability of sheet metals- principle, process parameters, equipment and application of the following processes: deep drawing, spinning, stretch forming. Plate bending, spring back, press brake forming, Introduction to forming, electro hydraulic forming, magnetic pulse forming. Introduction to press work – coining, embossing etc., Design of sheet metal dies. Powder Metallurgy: fabrication routes, powder size determination – micro and nano level, powder consolidation routes, compacting, sintering, hot pressing, sintering, hot isostatic pressing, field assisted sintering technologies.

Textbook(s):

1. Kalpakjian, “Manufacturing Engineering and Technology”, Addison Wesley.
2.A. Ghosh and A.K. Mallik, “Manufacturing Science”, East West Press.

References:

1. M.P. Groover, “Modern Manufacturing Processes”.
2. R. W. Heine, C. R. Loper and P. C. Rosenthal, “Principles of Metal Casting”, Tata-McGraw Hill.
3. G. E. Dieter, “Mechanical Metallurgy (Part IV)”, Tata-McGraw Hill.
4. B. Avitzur, “Metal Forming: Processes and Analysis”.
5. G.W. Rowe, “Industrial Metal Working Processes”.

Paper Code(s): MEC-211	**L**	**P**	**C**
Paper: Thermal Engineering – I	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the concepts of laws of thermodynamic and apply them to determine the feasibility of any process.
2.	To understand the principles of pure substance and to be able to determine exergy of any system.
3.	To understand the principle of vapour power cycle and its thermal refinement.
4.	To understand the working of I.C engine and Gas Turbine engine and able to compute its performance parameters.

Course Outcomes (CO)

CO 1	Develop understanding of first and second law of thermodynamics and use it to determine feasibility of a process
CO 2	Evaluate the properties of a pure substance using different property relations and determine entropy changes for different types of processes and the reversibility or irreversibility of such processes.
CO 3	Analyze the performance of simple Rankine cycle and improve its performance with thermal refinement.
CO 4	Examine various gas power cycles and their applications in automotive and aviation sector.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	3	3	3	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	2	-	-	-	-	2
CO 3	3	3	3	3	-	-	2	-	-	-	-	2
CO 4	3	3	3	3	-	-	2	-	-	-	-	2

UNIT-I

Basic definitions and Laws of Thermodynamics: Thermodynamic systems: Closed, Open and Isolated systems, Microscopic and Macroscopic view, Intensive and Extensive properties, Zeroth law of Thermodynamics, Phase, State, Process, Cycle, Point functions and Path functions, Work and Heat, First Law of Thermodynamics, Internal energy, Non flow processes, Concept of Flow work, Analysis of steady flow and unsteady flow processes and their applications, Limitations of First law, Second Law of Thermodynamics, Reversible and Irreversible processes, Reversed Carnot cycle, Carnot's Theorem, Clausius inequality, Entropy, Change in Entropy during various processes.

UNIT-II

Availability and Irreversibility: High grade and low grade energy, Available and unavailable energy, Dead state, Loss of available energy due to Heat transfer through a Finite temperature difference, Availability, Reversible work and Irreversibility, Availability in non flow systems, Second law efficiency.
Thermodynamic Property Relations: Maxwell Relations, Clapeyron Equation.
Properties of a Pure Substance: Phase equilibrium of a pure substance on T-V diagram, Normal boiling point of Pure substance, Saturation states, Compressed liquid, P-V & P-T diagram of a pure substance, Steam and its different states, Use of Steam tables and Mollier diagram, Different processes of vapour on P-V and T-S diagrams, Measurement of Dryness fraction.

UNIT-III

Vapour Power Cycles: Carnot vapour power cycles, drawbacks as a reference cycle, Simple Rankine cycle, description, T- S diagram, Analysis for performance, comparison of Carnot and Rankine cycles, Effects of pressure and temperature on Rankine cycle performance, Actual vapour power cycles, Ideal and practical regenerative Rankine cycle, open and closed feed water heaters, Reheat Rankine cycle.
Boiler: Classification of Boiler, Boiler mountings and Boiler Accessories, Once through Boiler, Working and construction of Babcock and Wilcox boiler, Lancashire boiler.

UNIT – IV

Gas power cycle: Carnot cycle, Otto cycle, Diesel cycle, Dual cycle, Two stroke and Four stroke Cycles, Working of S.I Engine and C.I Engine, Valve timing diagram of S.I engine and C.I engine.
Gas Turbines: Brayton cycle, Thermal refinements, Performance of Gas turbines, Combined cycle, Principles of Jet Propulsion, Turbojet engines.

Textbook(s):
1. P K Nag Basic and Applied Thermodynamics 5th edition McGraw Hill
2. Mathur & Sharma Internal Combustion Engine, Dhanpat Rai Publication.

References:
1. M.J. Moran & H.N. Shapiro “Fundamentals of Thermal Engineering” John Wiley & sons.
2. S L Somasundaram “Engineering Thermodynamics”, New Age International Publishers.
3. R. K. Rajput, “Engineering Thermodynamics”, Lakshmi Publications
4. Y. A. Cengel & M. A Boles “Thermodynamics- An Engineering Approach ”, 6th edition Tata McGraw Hill
5. Gordon Rosers, & Yon Mahew; Engineering Thermodynamics”, Pearson.

Paper Code(s): MEC-253	**L**	**P**	**C**
Paper: Theory of Machines Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Theory of Machines) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To study and verify the inversions of four bar (4R), single slider (3R-1P) crank and double slider (2R-2P) crank mechanism and also prove Grashof's Law.
2. To find out experimentally the Coriolis component of acceleration and compare with theoretical values
3. To study various types of CAM and follower mechanisms. Also, draw the CAM profile for the given CAM apparatus and determine jumping speed.
4. Draw velocity and acceleration diagram of engine mechanism using Klien's construction
5. To study various types of gear and gear trains and to determine gear ratio of simple, compound and epicyclic gear trains.
6. To calculate the torque on a Planet Carrier and torque on internal gear using epicyclic gear train and holding torque apparatus.
7. To determine the radius of gyration and moment of Inertia of a given rod.
8. To study and verify the motion of any one Governor.
9. To study and verify the gyroscopic law of motion.
10. To study and verify the dynamic balancing of rotating masses.
11. To determine the natural frequency of undamped free vibration of the given spring mass system.
12. To find the moment of inertia of a fly wheel.
13. To determine whirling speed of shaft theoretically and experimentally.

Paper Code(s): MEC-255	**L**	**P**	**C**
Paper: Strength of Materials Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Strength of Materials) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To perform the Hardness Test (Rockwell, Brinell & Vicker's test) and find the Hardness Number of different materials (MS, HSS, Wood, C.I., Al specimens).
2. To perform the Impact Test on a standard notched specimen to evaluate its Impact Number.
3. To perform the Tensile/Compression Test in ductile/brittle materials, draw a stress-strain curve and evaluate various mechanical properties of a given specimen.
4. To perform Shear Test and find maximum (ultimate) shear strength of given test specimen.
5. To perform the Bending /Deflection Test on a beam and evaluate its Young's Modulus.
6. To perform the Torsion Test and find modulus of rigidity, rupture stress (maximum shear stress), shear stress at yield point.
7. To determine Buckling loads of long columns with different end conditions.
8. To measure mechanical strain in a given beam using strain gauges.
9. To determine the different mechanical properties of given material under creep failure.
10. To determine flexural strength (modulus of rupture) of concrete beam.
11. To determine the endurance limit of the given specimen under fatigue or cyclic loading.
12. To find the Shear Modulus of two different materials; Aluminium and Steel using two twist and bent test rigs are used.
13. To determine the different mechanical properties of a given close coiled helical spring.

Paper Code(s): MEC-257	**L**	**P**	**C**
Paper: Thermal Engineering – I Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Thermal Engineering - I) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To draw the valve timing diagram of a Single Cylinder Four Stroke CI Engine.

2. To draw the valve timing diagram of a Single Cylinder Four Stroke SI Engine.

3. To determine Exergy destruction of Exhaust Gas Calorimeter of Petrol Engine test rig at different load.

4. To determine Exergy destruction of Exhaust Gas Calorimeter of Diesel Engine test rig at different load.

5. To determine the dryness fraction of given steam sample.

6. Visit and understanding of thermal power plant.

7. Thermodynamic analysis of Rankine cycle.

8. Comparative thermodynamic analysis of Otto, diesel and dual for the given condition.

9. Comparative analysis of air standard cycles under stated condition.

10. Study and analysis of Gas-Turbine cycle.

11. To study the working and construction different type of Boilers.

Paper Code(s): MEC-259	**L**	**P**	**C**
Paper: Manufacturing Science and Technology – I Lab	**-**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Manufacturing Science and Technology - I) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To determine the percentage of clay content in dry sand.
2. To determine the grain fineness number of a given sand specimen.
3. To Determine the moisture content quickly in fresh sand and moulding sand.
4. To determine the compressive strength of moulding sand.
5. To determine the permeability number of moulding sand.
6. Mould preparation and casting of metals after preparation of suitable moulds.
7. Laboratory experiments in fabrication processes using GMAW process.
8. Laboratory experiments in fabrication processes using Plasma Arc welding.
9. Laboratory experiments in fabrication processes using GTAW process.
10. Inspection of weld joints and welding defects.
11. Develop a flat blank layout, transfer the layout to the sheet metal, cut and form to the desired shape.
12. Practicing smithy or forging of carbon steels and testing of its property changes.
13. Form parts from metallic powders, record and plot pressing data, perform destructives tests on sintered powder metal parts.

Paper Code(s): MEC-254	**L**	**P**	**C**
Paper: Manufacturing Science and Technology – II Lab	**-**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Manufacturing Science and Technology - II) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Generation of different angles of a single point cutting tool on a sample workpiece.
2. Perform various machining operations on lathe machine tool.
3. To evaluate shear angle as a function of the rake angle of the tool.
4. Measurement and analysis of cutting forces in orthogonal turning for different materials at different speeds, feed and depth of cut.
5. Measurement of temperature at tool chip interface.
6. A study of chips formed at different speed, feed, depth of cut, for different materials
7. Flank wear – time characteristics for single point cutting tools for different materials at different speeds, feed and depth of cut.
8. To study the characteristic features of milling machine and to machine the hexagonal head of a workpiece.
9. To study the characteristic features of Shaper and to machine a V-block out of the workpiece provided.
10. To study the characteristic features of a Drilling machine and to drill, ream and tap holes on the given workpiece.
11. To study the characteristics of CNC Lathe and CNC milling machines.
12. To study the characteristic features of Electric Discharge Machining processes.

Paper Code(s): MEC-256	**L**	**P**	**C**
Paper: Thermal Engineering – II Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Thermal Engineering - II) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1.To conduct the performance test on the Diesel engine test rig.

2. To conduct the performance test on the Petrol engine test rig

3. To prepare heat balance sheet of single cylinder four stroke diesel engine.

4. To prepare heat balance sheet of single cylinder four stroke Petrol engine.

5. To determine COP of refrigeration system based on vapor compression Cycle.

6. Study the working of different types of Compressors.

7. Visit to the refrigeration plant.

8. Determine the effect of load on the components of Heat balance of an I.C engine.

9. Determine the composition of exhaust gas by Orsat Apparatus.

10. Study the working of Vapor Absorption Refrigeration System.

Paper Code(s): MEC-258	**L**	**P**	**C**
Paper: Machine Design – I Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Machine Design - I) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To design and draw a Spigot and Socket Cotter Joint for a given load under the allowable stress properties of the material.
2. To design and draw a Knuckle Joint for a given load under the material properties constraints.
3. To design and draw a pipe joint carrying pressured fluid within safe stress capabilities of the givens material.
4. To design and draw a protected type Rigid Flanged Coupling for connecting two power transmitting perfect coaxial shafts.
5. To design and draw a bushed pin type Flexible Coupling (Ajax) for connecting two slightly misaligned shafts.
6. To design a quadruple riveted double strap butt joint for the longitudinal seam and circumferential seam of a boiler shell.
7. To design and find the size of an eccentrically loaded Welded Joint.
8. To design and draw a Screw Jack for lifting a given load.
9. To design a pair of Spur Gear Reducer for transmitting a given power between two shafts.
10. To design a Bell Crank Lever for moving a given load with a given mechanical advantage.
11. To design a closed coiled helical spring for the valve mechanism of an engine.

Note: The drawing/drafting of the designed parts based on the actual calculations must be done on any suitable available drafting software.

Paper Code(s): MEC-206	**L**	**P**	**C**
Paper: Manufacturing Science & Technology - II	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the concepts of metal cutting and tool materials.
2.	To develop an understanding of the various machine tools.
3.	To introduce students to different gear forming methods and jigs & fixtures
4.	To acquire a fundamental knowledge on non-traditional machining processes.

Course Outcomes (CO)

CO 1	Understand and apply concepts of cutting tool geometry, materials, mechanism of chip formation and mechanics of metal cutting
CO 2	Illustrate and identify the various constructional features and operations performed on machine tools.
CO 3	Analyse the kinematic motions and associated mathematical relationships in a machine tool.
CO 4	Select a machine tool, cutting tool and holding devices as per the requirement of metal cutting and submit report in a team.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	3	-	3	-	2	-	-	-	-	-	-
CO 2	3	-	2	-	-	2	-	-	-	-	-	-
CO 3	3	3	2	2	-	2	-	-	-	-	-	-
CO 4	3	2	2	3	-	2	-	-	3	3	-	-

UNIT-I

Theory of Metal Cutting: Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems of Merchant's analysis. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life. Tool Failure Criteria, Taylor's Tool Life equation. Problems on tool life evaluation.

Cutting Tool Materials: Desired properties and types of cutting tool materials, Cutting fluids and its desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool, work piece and chip. Measurement of tool tip temperature.

UNIT-II

Lathe, Shaper, Planer and Slotter: Classification, constructional features, work and tool holding devices for General lathe, Turret and Capstan Lathe. Tool Layout, shaping Machine, Planing Machine, Driving mechanisms

of lathe, shaping and planing machine tools, Different operations on lathe, shaping machine, planing, slotting machine tools. Problems on machining time calculations, thread cutting.

Drilling: Classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, Basic principle of design of drill bits, drill materials, related problems.

UNIT-III

Milling and Grinding: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations. Indexing Methods: Simple and compound. Problems on indexing and machining time calculation. Grinding: Selection of grinding wheel, Classification, constructional features of grinding machines (Centerless, cylindrical and surface grinding), Dressing and truing of grinding wheels.

Broaching process: Principle of broaching, Applications, advantages and limitations. Finishing and other Processes Lapping and Honing operations – Principles, arrangement of set up and application. Super finishing process, polishing, buffing operation and application.

Gear Manufacturing: Gear forming, gear generation, gear shaping and gear hobbing.

UNIT - IV

Jigs & Fixtures: Important considerations in jigs and fixture design. Main principles of designing of jigs & fixtures, elements of Jigs and fixtures. Different devices and methods of locations. Different types of clamps used in jigs & fixtures.

Introduction to CNC machines- Principles of operation. Basics of Manual part programming methods.

Non- Traditional Machining: Need and classification of non-traditional machining, Principle, equipment & operation of Electric discharge machining, Laser Beam Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining.

Textbook(s):

1. B.L. Juneja, G. S. Sekhon, Nitin Seth, “Fundamental of Metal Cutting and Machine Tools”, New Age International; 2nded.
2. A. Ghosh and A.K. Mallik, “Manufacturing Science”, East West Press.
3. P. H. Joshi, “Jigs and Fixtures”, Tata McGraw Hill;2nd ed.

References:

1. G. Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, Taylor and Francis; 3rd ed.
2. M. C. Shaw, “Metal Cutting Principles”, Oxford University Press.
3. J.A. McGeough, “Advanced Methods of Machining”, Springer International Edition.
4. P.C. Sharma, “A Text Book of Production Engineering”, S. Chand, New Delhi;(2004)
5. H. S. Bawa, “Workshop Technology”, Vol.2, Tata McGraw Hill;(2004)
6. G.K. Lal, “Introduction to Machining Science”, New age International.
7. A. Bhattacharya,Metal cutting Theory and Practice- New Central Book Agency.

Paper Code(s): MEC-208	**L**	**P**	**C**
Paper: Material Science and Metallurgy	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To develop the knowledge of lattice structure and their defects.
2.	To develop the relation between structural and mechanical properties of metals for the selection of product design.
3.	Identify the microstructure and properties of Iron-Iron carbide Phase diagram.
4.	To develop the knowledge of various composite materials and their applications.

Course Outcomes (CO)

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

CO 1	Summarize the properties of crystal structures of metallic elements and understand the mechanism of diffusion and deformation.
CO 2	To relate the material behaviour under environmental conditions and interpret the characteristics of steel through iron- iron carbide and TTT diagram.
CO 3	Relate the properties of steel with heat treatment processes and study the effect of alloying elements in steel.
CO 4	Classify types of corrosion and composites.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (Scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	1	3	2	-	-	-	-	-	-	3	3
CO 2	3	2	3	2	-	-	-	-	-	-	3	3
CO 3	3	2	3	2	-	-	-	-	-	-	3	3
CO 4	3	-	-	2	-	3	3	-	-	-	3	3

UNIT – I

Structure of metal: Crystal structure (BCC, FCC and HCP), Packing factor and density calculation, miller indices, imperfections in solids.

Diffusion: Diffusion mechanisms, steady state and non-steady state diffusion, factors affecting diffusion.

Deformation: Slip, twinning, critical resolved shear stress, effect of cold working and hot working on mechanical properties, principles of recovery, re-crystallization and gain growth.

UNIT – II

Fracture: Types of fracture- ductile and brittle, ductile to brittle transition temperature (DBTT), Fatigue- Endurance limit, S-N Curve, factors affecting fatigue.

Creep: Mechanism of creep, creep curve, basic consideration in the selection of material for high temperature service.

Equilibrium diagram: solids solutions and alloys, Gibbs phase rule, unary and binary eutectic phase diagram, lever rule, Iron- Iron carbide Phase diagram, TTT-diagram, Effect of alloying elements on TTT diagram.

UNIT–III

Heat Treatment: Principles and purpose of heat treatment of plain carbon steels, annealing, normalizing, hardening, tempering, quenching, austempering, martempering, case hardening processes – carburizing, nitriding, cyaniding, induction and flame hardening, Hardenability: determination of hardenability, Jominy end quench test.

Materials: Types of Plain carbon steels, effect of alloying elements on steel, Cast iron-white, grey, malleable and nodular cast iron, properties and application of cast iron, properties and uses of high speed steel, stainless steel, spring steel, Non-ferrous materials.

UNIT– IV

Corrosion: Types of corrosion, mechanism of corrosion, preventions against corrosion.

Introduction to composite materials- Classification, Properties and applications of composite materials.
Surface Coatings: Introduction to metallic coating and coating methods.

Text Books (s):

1. W. D. Callister, David G. Rethwisch, “Materials Science and Engineering: An Introduction”, Wiley & Sons; 9thed. (2013).
2. K. I. Parashivamurthy, “Material Science and Metallurgy”, Pearson.
3. Sidney H. Avner, “Introduction to Physical Metallurgy”, Tata McGraw-Hill, New Delhi; (1997).

Reference Books:

1. L. Krishna Reddi, “Principles of Engineering Metallurgy”, New Age Publication, New Delhi; (2001)
2. Buduisky et. al., “Engineering Materials & Properties”, Prentice Hall India, New Delhi; (2004)
3. Peter Haasten, “Physical Metallurgy”, Cambridge Univ. Press; (1996)
4. Raymond A. Higgin., “Engineering Metallurgy Part 1”, Prentice Hall India, New Delhi; (1998)

Paper Code(s): MEC-210	**L**	**P**	**C**
Paper: Thermal Engineering – II	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the working of steam nozzle at design condition and off design condition. To differentiate clearly between impulse and impulse-reaction turbine.
2.	To understand the working of reciprocating compressor & refrigeration cycle.
3.	To understand the combustion in I.C engine and appreciate the concept of knocking.
4.	To be able to compute performance parameters of an I.C engine and to determine components of heat balance of given i.C engine.

Course Outcomes (CO)

CO 1	To determine the mass flow rate through steam nozzle and to be able to determine blade efficiency and stage efficiency of steam turbine blading.
CO 2	To determine work requirement of a reciprocating compressor and to analyze refrigeration system based on vapour compression refrigeration system.
CO 3	Explain the combustion in I.C engine and enumerate the factors responsible for knocking.
CO 4	Evaluate performance parameter of I.C engine and draw heat balance sheet of specified engine.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	3	3	3	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	2	-	-	-	-	2
CO 3	3	3	3	3	-	-	2	-	-	-	-	2
CO 4	3	3	3	3	-	-	2	-	-	-	-	2

UNIT-I

Steam Nozzle: Types of nozzles, flow of steam through nozzles, condition for maximum discharge through nozzle, nozzle efficiency, effect of friction and off design condition of convergent nozzle and convergent-divergent nozzle.

Steam Turbine: Working principle and types of steam turbines, velocity diagrams for impulse and reaction turbines, compounding of impulse turbines, optimum velocity ratio and maximum efficiency, comparison of impulse and reaction turbines, reheat factor.

UNIT-II

Air Compressors: Steady flow analysis, isothermal, adiabatic and polytropic compression, single- and multi-stage compression, ideal intermediate pressure, compressor clearance, volumetric and isothermal efficiency, minimum work requirement of a compressor.

Refrigeration Cycle: Vapour compression refrigeration cycle, description, analysis, refrigerating effect, power required, unit of refrigeration, COP, Refrigerants and its desirable properties. Vapor absorption refrigeration system.

UNIT-III

Internal Combustion Engine: Combustion in S.I. engine, Combustion in C.I. engine and its stages, Knocking in S.I. and C.I. engine and its detrimental effect, Factors affecting knocking in S.I. and C.I. engine.

UNIT – IV

I.C. Engine performance: Measurement of performance parameters of an engine, different methods to determine Indicated power and friction power of an engine, components of heat balance sheet of a given Engine, Ignition system, Fuel injection system, Lubrication system.

Textbook(s):

1. S. Domkundwar, Thermal Engineering, Dhanpat Rai & Co (p) Ltd.
2. P.K Nag, Applied Thermodynamics, Tata McGraw Hill (p) Limited.
3. Mathur & Sharma, Internal Combustion Engine, Dhanpat Rai Publication.

References:

1. Onkar Singh, Applied Thermodynamics, New Age International (p) Limited.
2. Cohen & Rogers, Gas Turbines, Pearson Prentice Hall, ISBN- 9780582236325.
3. R. K. Rajput, “Engineering Thermodynamics”, Lakshmi Publications.
4. V.Ganesan, “Internal Combustion Engine “, Tata McGraw Hill Publishing Co., New Delhi.
5. Gordon Rosers, & Yon Mahew; Engineering Thermodynamics”, Pearson.

Paper Code(s): MEC-212	**L**	**P**	**C**
Paper: Machine Design – I	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand ab-initio design concepts under various constraints, stress concentration and dynamic loading. Also analyse the design of static joints and pipes.
2.	To conceptualise joints for power transmission in rotating parts, suspension parts and in leverage.
3.	To analyse bolted & screwed fastenings and structural plates joining for complex engineering applications under myriad of loads.
4.	To thoroughly understand the design procedure for speed variation effects in toothed elements and power screws.

Course Outcomes (CO)

CO 1	Grasp the systematic design procedure & design principles considering constraints of various methods of manufacture and effect of static & dynamic forces on joints for rods.
CO 2	Synthesis of keyed-coupled shafts and stress analysis of flexible elements & levers.
CO 3	Design analysis of fastening threads and various temporary & permanent joints for plates.
CO 4	Analyse the effect of changing speeds on designed toothed elements and efficient power transmitting devices.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO 1	3	3	3	3	3	2	2	2	1	1	2	3
CO 2	3	3	3	3	3	2	2	2	1	1	2	3
CO 3	3	3	3	3	3	2	2	2	1	1	2	3
CO 4	3	3	3	3	3	2	2	2	1	1	2	3

UNIT-I

Introduction: Systematic Design Process (SDP), Basic principles for mechanical design, Use of standards. Manufacturing consideration in design of casting & machining parts.

Dynamic and fluctuating stresses, fatigue failure and endurance limit, design under combined direct & varying stresses. Stress concentration, causes and remedies in design.

Factor of safety and it's affecting factors, Tolerances and fits as per BIS, Materials selection, Designation of steels. Detailed design procedure of Spigot & Socket Cotter joint, Knuckle joint, Pipe joint. Numerical Design Problems.

UNIT-II

Shafts, keys and couplings: Transmission Shafts, materials, design of shafts on strength & rigidity basis and under combined torsional and bending loads as per ASME code. Keys, types and applications. Design of rigid and pin bushed flexible couplings.

Levers, types, Design of Bell crank lever.

Springs and their applications, design of close coiled helical springs. Numerical Design Problems.

UNIT-III

Riveted & Welded Joints: Types of riveted joints, Failure modes, strength equations, joint efficiency, Riveted joint for boiler shells, Riveted joints under direct and eccentric loads. Welded joints, strength of parallel, transverse & combined filled welded joints, axially loaded unsymmetrical welded joint, eccentrically loaded welded joints, welded joints subjected to bending moment and torsional moment.
Threaded Joints: Types of screwed fastenings, Initial tightening loads in bolts, Torque requirement, Uniform strength bolt, Direct & eccentrically loaded bolted joints. Numerical Design Problems.

UNIT - IV

Power Screws: Types of threads of power screws - Square, trapezoidal & Acme threads, Torque requirement, efficiency, irreversibility & self-locking, Complete analysis of design of screw jack.
Spur Gear: Classification of Gears, spur gear terminology, Gear tooth failure, Lewis equation for beam strength of tooth, dynamic and wear loads. Numerical Design Problems.

Textbook(s):
1. V.B. Bhandari, “Design of Machine elements”, Tata McGraw Hill Education Private Ltd. Third Edition (2012)
2. Maleeve Hartman and O.P. Grover, “Machine Design”, CBS Publishers& Distributors Pvt. Ltd. Sixth Edition (2015)

References:
1. K. Mahadevan, “Design Data Book”, CBS Publishers & Distributors.
2. J.E. Shigley & C.R. Mischke, "Mechanical Engineering Design”, Tata McGraw Hill Co. Inc.
3. P.C. Sharma and D.K Aggarwal., “Machine Design”, S.K. Kataria & Sons.
4. R.C. Juvinal andK.M. Marshek, “Fundamentals of Machine component Design”, Wiley India .
5. R.I. Norton, “Machine Design” Pearson.

Paper Code(s): BS-202	**L**	**P**	**C**
Paper: Probability, Statistics and Linear Programming	**4**	**-**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To understand probability and probability distributions.
2:	To understand methods of summarization of data.
3:	To understand and use test for hypothesis.
4:	To understand methods for solving linear programming problems.

Course Outcomes (CO):

CO1:	Ability to solve probability problems and describe probability distributions.
CO2:	Ability to describe and summarize data.
CO3:	Ability to use test for hypothesis.
CO4:	Ability to formulate and solve linear programming problems.

Course Outcomes (CO to Programme Outcomes (PO) Mapping (scale 1: low, 2: Medium, 3: High

CO/PO	***PO01***	***PO02***	***PO03***	***PO04***	***PO05***	***PO06***	***PO07***	***PO08***	***PO09***	***PO10***	***PO11***	***PO12***
CO1	-	3	1	1	1	-	-	-	-	-	1	2
CO2	-	3	1	1	1	-	-	-	-	-	1	2
CO3	-	3	2	2	1	-	-	-	-	-	2	2
CO4	-	3	3	3	1	-	-	-	-	-	2	2

Unit I

Basics: Probability and Statistical models, Sample Spaces and Events, Counting Techniques, Interpretations and Axioms of Probability, Unions of Events and Addition Rules, Conditional Probability, Intersections of Events and Multiplication and Total Probability Rules, Independence, Bayes' Theorem, Random Variables.
Discrete and Continuous Random Variables and Distributions: Probability Distributions and Probability Mass / density Functions, Cumulative Distribution Functions, Mean and Variance of a Random Variable, Discrete and continuous Uniform Distribution, Binomial Distribution, Geometric and Negative Binomial Distributions, Hypergeometric Distribution, Poisson Distribution. Normal Distribution, Normal Approximation to the Binomial, and Poisson Distributions; Exponential Distribution, Erlang and Gamma Distributions, Weibull Distribution, Lognormal Distribution, Beta Distribution.

Unit II

Joint Probability Distributions for Two Random Variables, Conditional Probability Distributions and Independence, Joint Probability Distributions for Two Random Variables, Covariance and Correlation, Common Joint Distributions, Linear Functions of RandomVariables, General Functions of Random Variables, Moment-Generating Functions.
Numerical Summaries of Data, Stem-and-Leaf Diagrams, Frequency Distributions and Histograms, Box Plots, Time Sequence Plots, Scatter Diagrams, Probability Plots. Point Estimation, Sampling Distributions and the Central

Limit Theorem without proof, General Concepts of Point Estimation, Methods of Point Estimation, Statistical Intervals for a Single Sample.

Unit III

Hypotheses Testing for a SingleSample: Tests on the Mean of a Normal Distribution with Variance Known / Unknown, Tests on the Variance and Standard Deviationof a Normal Distribution, Tests on a Population Proportion, Testing for Goodness of Fit, Nonparametric tests (Signed, Wilcoxon), Similarly Statistical Inference forTwo Samples.
Regression and Correlation: Linear Regression, Least Squares Estimators, Hypotheses testing for simple linear regression, Confidence Intervals, Adequacy of model, Correlation, Transformed Variables, Logistic Regression. Similarly, for multiple linear regression including aspects of MLR.

Unit IV

Linear Programming: Introduction, formulation of problem, Graphical method, Canonical and Standard form of LPP, Simplex method, Duality concept, Dual simplex method, Transportation and Assignment problem.

Textbooks:
1. *Applied Statistics and Probability for Engineers* by Douglas G. Montgomery and Runger, Wiley, 2018
2. *Linear Programming* by G. Hadley, Narosa, 2002

References:
1. *Miller and Freund's Probability and Statistics for Engineers* by Richard A. Johnson, Pearson, 10th Ed., 2018.
2. *Probability & Statistics for Engineers & Scientists* by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Pearson, 2016.
3. *Statistics and probability with applications for engineers and scientists using Minitab, R and JMP*, C. Gupta, Irwin Guttman, and Kalanka P. Jayalath, Wiley, 2020.
4. *Probability and Statistics for Engineering and the Sciences*, Jay Devore, Cengage Learning, 2014.
5. *Probability and Statistics in Emgineering*, William W. Hines, Douglas C. Montgomery, David M. Goldman, and Connie M. Borror, Wiley, 2003.
6. *Operations Research: An Introduction* by Hamdy A. Taha, Pearson, 10th Edition, 2016

Paper Code(s): HS-204	**L**	**P**	**C**
Paper: Technical Writing	**2**	**-**	**2**

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks
3. This is an NUES paper, hence all examinations to be conducted by the concerned teacher.

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To improve grammar and sentence structure and build vocabulary.
2:	To understand how to write different types of writings.
3:	To understand how to compose different types of business documents.
4:	To understand business ethics and develop soft skills.

Course Outcomes (CO):

CO1:	Ability to improve grammar and sentence structure and build vocabulary.
CO2:	Ability to write different types of writings with clarity.
CO3:	Ability to write different types of business documents.
CO4:	Ability to apply business ethics and enhance personality.

Course Outcomes (CO to Programme Outcomes (PO) Mapping (scale 1: low, 2: Medium, 3: High

CO/PO	***PO01***	***PO02***	***PO03***	***PO04***	***PO05***	***PO06***	***PO07***	***PO08***	***PO09***	***PO10***	***PO11***	***PO12***
CO1	-	-	-	-	-	1	-	-	-	3	-	-
CO2	-	-	-	-	-	1	-	-	-	3	-	-
CO3	-	-	-	-	-	1	-	-	-	3	-	-
CO4	-	-	-	-	-	1	-	3	-	3	-	-

Unit I

Grammar and Vocabulary--- Types of sentences (simple, complex and compound) and use of connectives in sentences, Subject-verb agreement, Comprehension, Synonyms and Antonyms, Homophones and Homonyms, Word Formation: Prefixes and Suffixes, Indianism, Misappropriation and Redundant Words, Question Tags and Short Responses.

Unit II

Writing Styles -- Expository, Explanatory, Descriptive, Argumentative and Narrative.
Precis writing, Visual Aids in Technical Writing, Plagiarism and Language Sensitivity in Technical Writing, Dialogue Writing, Proposals: Purpose and Types.

Unit III

Letters at the Workplace—letter writing: Request, Sales, Enquiry, Order and Complaint.
Job Application---Resume and Cover letter, Difference between Resume and CV, Preparation for Interview.
Meeting Documentation--- Notice, Memorandum, Circular, Agenda, Office Order and Minutes of meeting, Writing Instructions.

Unit IV

Ethics and Personality Development-----The Role of Ethics in Business Communication—Ethical Principles, Time Management, Self-Analysis through SWOT and JOHARI Window, Emotional Intelligence and Leadership Skills, Team Building, Career Planning, Self Esteem.

Textbook:

1. Meenakshi Raman and Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press, New Delhi (2015).

References:

1. Sanjay Kumar and Pushp Lata, Communication Skills, Oxford University Press, New Delhi (2015).
2. Herta A Murphy, Herbert W Hildebrandt, Jane P Thomas, Effective Business Communication, Tata McGraw-Hill, Hill Publishing Company Limited, Seventh Edition.

Paper Code(s): BS-252	**L**	**P**	**C**
Paper: Probability, Statistics and Linear Programming Lab	**-**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Probability, Statistics and Linear Programming) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

Implementation to be done in MATLAB or in equivalent software.

1. Installation of Scilab and demonstration of simple programming concepts like marix multiplication (scalar and vector), loop, conditional statements and plotting.

2. Program for demonstration of theoretical probability limits.

3. Program to plot normal distributions and exponential distributions for various parametric values.

4. Fitting of binomial distributions for given n and p.

5. Fitting of binomial distributions after computing mean and variance.

6. Fitting of Poisson distributions for given value of lambda.

7. Fitting of Poisson distributions after computing mean.

8. Fitting of normal distribution when parameters are given.

9. Fitting of linear regression line through given data set and testing of goodness of fit using mean error.

10. Fitting of Multiple Linear Regression (MLR) curve through given data set and testing of goodness of fit using mean error.

11. Solve a LPP of three variable using Simplex Method.

12. Solve a Transportation problem of three variables.

13. Solve an Assignment problem of three variables.

Heat and Mass Transfer	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	5	PC	PC	MEC-311
MAE	5	PC	PC	MEC-311

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To introduce the students about the knowledge of conduction, convection, thermal radiation.
2.	To enable them to make calculations of heat transfers that will help them in design and analysis of any thermal system.
3.	To introduce the students about different types of heat exchangers.
4.	To introduce the students about the knowledge of condensation, boiling and mass transfer.

Course Outcomes (CO)

CO 1	Evaluate rate of heat transfer by conduction, convection and radiation for standard industrial configuration and solve problems.
CO 2	Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.
CO 3	Apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations; and explain basic laws for radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.
CO 4	Explain the phenomena of boiling and condensation; and apply diffusive and convective mass transfer equations and correlations to solve problems for different applications.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	-	1	2	-	2	-	-	2
CO 2	3	3	3	3	2	-	2	-	2	-	-	2
CO 3	3	3	3	3	-	-	2	-	2	-	-	2
CO 4	3	3	3	3	2	-	2	-	2	-	-	2

UNIT-I

Conduction: Introduction to Heat Transfer, Various modes of heat transfer, Fourier's Law, thermal conductivity of solids, liquids and gases, factors influencing conductivity, general differential equation of conduction, one dimensional steady state conduction, simple cases of conduction through a plane and composite wall, cylinder and sphere, thermal diffusivity, overall heat transfer coefficient, Heat transfer through cylindrical & Spherical surfaces, Critical thickness of insulation.

Fins and Transient Conduction: Heat transfer from extended surfaces, conduction convection system, general conduction analysis, fins of uniform cross-sectional area, fin performance, Transient heat conduction: lumped system analysis.

UNIT-II

Forced Convection: Introduction, dimensional analysis of forced convection and important dimensionless numbers, velocity and thermal boundary layer, laminar boundary layer equations for internal and external flows, laminar forced convection on a flat plate and in a tube.

Natural Convection: Basic Concepts, dimensional analysis of natural convection and important dimensionless numbers, empirical relationship for natural convection, natural convection on a flat plate and in a tube.

UNIT-III

Heat Exchanger –Types of Heat exchangers, overall heat transfer coefficient, design of heat exchangers logarithmic mean temperature difference (LMTD) method, effectiveness-NTU method of heat exchangers, fouling factor and correction factor.

Thermal Radiation: Concept of thermal radiations, radiation properties of surfaces, type of bodies (black and non black bodies), Kirchhoff's law, Planck's distribution law, Wein's displacement law, Stefan-Boltzmann's relation, intensity of radiation, radiant heat exchange between black and grey surfaces, configuration factor, radiation shielding, solar radiation; green house effect.

UNIT – IV

Condensation and Boiling: Introduction to condensation phenomena, Film and Drop wise condensation, Film-wise condensation on vertical plate and horizontal tubes. Boiling: Classification, Flow Regimes of Pool boiling, Heat transfer correlations in boiling and condensation.

Mass Transfer: Basic Concepts, Diffusion Mass Transfer, Fick's Law of Diffusion, Molecular and eddy diffusion; concept of mass transfer coefficients, theories of mass transfer, Heat and mass transfer phenomenon, molecular diffusion from an evaporating fluid surfaces, dimensionless analysis of convective mass transfer.

Textbook(s):

1. Incropera, Dewitt, "Fundamentals of Heat and Mass Transfer", Wiley India Pvt. Ltd.
2. R. C. Sachdeva, "Heat Transfers" McGraw Hill.

References:

1. Mahesh M. Rathore, "Engineering Heat and Mass Transfer", University Science Press.
2. P. K. Nag, "Heat and Mass Transfer", Tata McGraw Hill Book Company.
3. Holman, J.P., "Heat Transfer", Tata McGraw Hill Book Company.
4. Domkundwar S., Arora S. C., Domkundwar Anand V., "A Course in Heat and Mass Transfer", Dhanpat Rai & Company.

Heat and Mass Transfer Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	5	PC	PC	MEC-357
MAE	5	PC	PC	MEC-357

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Heat and Mass Transfer) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To find the thermal conductivity of an asbestos sheet.
2. To determine the thermal conductivity of metal rod.
3. To determine thermal conductivity of an insulating powder.
4. To determine overall heat transfer coefficient and the temperature distribution across the width of a composite wall.
5. To determine convective heat transfer coefficient, temperature distribution, efficiency and effectiveness of PIN-FIN in natural convection.
6. To determine convective heat transfer coefficient, temperature distribution, efficiency and effectiveness of PIN-FIN in forced convection.
7. To determine LMTD and effectiveness of parallel and counter flow heat exchanger.
8. To determine the forced convective heat transfer coefficient, for flow of air inside a horizontal pipe.
9. To determine the surface heat transfer coefficient for a heated vertical cylinder in natural convection
10. To determine Stefan-Boltzmann constant of radiation heat transfer.
11. To study boiling heat transfer phenomenon for pool boiling.
12. To determine emissivity of a test surface.

Industrial Engineering	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME/MAE	5	PC	PC	MEC-309

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand Production System used in Industries and Apply various techniques for forecasting and Inventory control.
2.	To apply the concept of work study and method study and implement the knowledge of control charts for Quality for quality improvement.
3.	To understand the concept of network models and flow shop scheduling.
4.	To interpret the concept of Industrial relations, Industrial disputes, Dispute settlement machineries and factory legislation.

Course Outcomes (CO)

CO 1	Understand Production System used in Industries and Apply various techniques for forecasting and Inventory control.
CO 2	Perform work & Method Study and Implement the knowledge of control charts for Quality in quality improvement
CO 3	Apply the concept of network models and flow shop scheduling in production
CO 4	Interpret the concept of Industrial relations, Industrial disputes, Dispute settlement machineries and factory legislation.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	-	3	3	3	-	3	2	2
CO 2	3	2	2	2	-	3	3	3	-	3	3	2
CO 3	3	2	2	-	-	3	3	3	-	2	2	2
CO 4	3	2	3	-	-	3	3	3	-	2	2	2

UNIT-I

Introduction: Production functions, Management systems, production and productivity.
Plant Organization: Principles of organization, Organization structure-line and staff organization.
Production Planning & Control: Types of products, demand, demand forecasting, scheduling and control of scheduling production control. Inventory Models – Deterministic manufacturing and purchase models – quantity discounts Queueing models – Poisson arrival and exponential service times – Single server and multi-server modelSimulation –Monte Carlo simulation – Numerical problems.

UNIT-II

Method Study: Definition and concepts, method study procedures, symbols, advantages, Operation process chart, Flow process charts, Two hand process chart, Motion study, micro motion, SIMO charts, Systems Concepts, Classification analysis techniques, Principle of motion economics.
Work Measurement: Definition, objectives & techniques, Time study equipment, performance rating, allowances, standard time, work sampling, PMTS.
Quality Management- Quality, Control Charts, Taguchi Philosophy. Service Quality. Total Quality Management (TQM), Six Sigma,

UNIT – III

Network Models- Project Networks- CPM / PERT- Project Scheduling – crashing networks and cost considerations – Resource leveling and smoothing, shortest route problem, Game theory – mixed strategies – dominance property – 2 x n and m x 2 games.
Flow shop scheduling– Johnsons algorithm for n jobs and two machines and n jobs and m machines.

UNIT-IV

Trade Unionism- Definition, Origin, Objectives of Trade Unions. Methods of Trade unions. Size and finance ofIndian Trade unions-size, frequency distribution, factors responsible for the small size. Finance-sources ofincome, ways of improving finance
Industrial relations- Definition and main aspects. Industrial disputes and strikes. Collective bargaining. Labour Legislation- Labour management cooperation/worker 's participation in management. Factory legislation. International Labour Organization.

Textbook(s):
1. Ravi Shankar, Industrial Engg. & Management, Galgotia Publications
2. S.K. Sharma, Industrial Engg. & Operation Management, S.K. Kataria & Sons.

References:
1. Joseph S. Martinich, Production & Operation Management, John Wiley & Sons.
2. Harold T. Amrine, John A. Ritchey, Colin L. Moodie, Joseph F. Kmec, Manufacturing organization and Management, Pearson publication, 6th edition
3. S. Anil Kumar, N. Suresh, Production and operations management, New age International, 2nd Ed.
4. M. Mahajan, Industrial Engg. & Production Management, Dhanpat Rai & Co.
5. Srivastava, S.C. (2012), Industrial Relations and Labour Laws, Vikas Publishing
6. Telsang, M. (2006), Industrial Engineering and Production Management. S.Chand
7. Thukaram, Rao (2004), M.E. Industrial Management. Himalaya Publishing House.
8. Sinha, P.R.N., Sinha I.B. and ShekharS.M. (2013), Industrial Relations, Trade Unions and Labour Legislation. Pearson Education
9. Chary, S.N. (2012), Production and Operations Management. Tata McGraw Hill

Metrology and Instrumentation	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	5	PC	PC	MEC-307

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	Design of part, tolerances and fits.
2.	Principles of measuring instruments and gauges and their uses.
3.	Determine error and analysing uncertainty in the measurements.
4.	Evaluation and inspection of surface roughness and textures.

Course Outcomes (CO)

CO 1	Explain the basic knowledge of measurements, metrology, and measuring devices.
CO 2	Understand the fundamentals and the working of comparators.
CO 3	Understand the fundamentals of various methods for the measurements of screw threads and the working of optical measuring instruments.
CO 4	Understand various advanced measuring devices and machine tool metrology and describe application of principle of metrology and measurements in industries.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	-	2	-	-	-	-	-	2
CO 2	3	3	3	3	-	3	-	-	-	-	-	2
CO 3	3	3	3	3	-	3	-	-	-	-	-	2
CO 4	3	3	3	2	-	3	-	-	--	-	-	2

UNIT-I

Principles of Measurement: Definition of Metrology, the difference between precision and accuracy. Sources of errors: Controllable and Random Errors, Effects of Environment and Temperature, Effects of support, alignment errors, application of Least Square principles, and errors in measurement of quality which is the function of other variables.

Length Standards: Line standards, end standards, and wavelength standards, transfer from line standards to end standards. Numerical based on line standards. Slip gauges – its use and care, methods of building different heights using different sets of slip gauges.

Limits, Fits, and Tolerances: Various definitions, IS919-1963, different types of fits, and methods to provide these fits. Numerical to calculate the limits, fits, and tolerances as per IS 919- 1963. ISO system of limits and fits; Gauges and their types, limit gauges – plug and ring gauges. Gauge Design – Taylor's Principle, wear allowance on gauges. Different methods of giving tolerances on gauges, Numerical.

UNIT-II

Comparators: Mechanical Comparators: Johanson Mikrokator and Sigma Mechanical Comparator. Mechanical-optical comparator. Principles of Electrical and electronic comparators. Pneumatic comparators – advantages, systems of Pneumatic Gauging:- Flow type and back pressure type, Principle of working of back pressure gauges, different types of sensitivities and overall magnification, Solex Pneumatic gauges and differential comparators. Numerical based on pneumatic comparators.

UNIT-III

Straightness and Flatness: Definition of Straightness and Flatness error. Numerical based on the determination of straightness error of straight edge with the help of spirit level and auto collimator. Numerical based on the determination of flatness error of a surface plate with the help of spirit level or auto-collimator.
Screw Thread Measurement: Errors in threads, Measurement of elements of screw threads – major dia, minor dia, pitch, flank angle, and effective diameter (Two and three-wire methods). Effect of errors in pitch and flank angles and its mathematical derivation. Numerical.

UNIT – IV

Instrument Calibration Methods: Introduction, Definition of Calibration, Need for Calibration, Characteristics of Calibration, Calibration Overall Requirements and Procedures, Calibration Methods/Procedures, Calibration Laboratory Requirements, Industry Practices and Regulations, Calibration and Limitations of a Digital System, Verification and Calibration of CNC Machine Tool, Inspection of the Positioning Accuracy of CNC Machine Tools, CNC Machine Error Assessment and Calibration, Calibration of 3-axis CNC Machine Tool, Calibration of a Coordinate Measuring Machine (CMM)
Surface Texture: Introduction, different types of irregularities, standard measures for assessment and measurement of surface finish.

Textbook(s):

1. R.K. Jain, “Engineering Metrology”, Khanna Publishers, Delhi.
2. I.C. Gupta, “Engineering Metrology”, Dhanpat Rai Publications, Delhi.

References:

1. F.W. Galyer& C.R. Shotbolt, “Metrology for Engineers”, ELBS edition.
2. Samir Mekid, Metrology and Instrumentation - Practical Applications for Engineering and Manufacturing, John Wiley & Sons, Inc. and ASME Press 2022.

Metrology and Instrumentation Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	5	PC	PC	MEC-355

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Metrology and Instrumentation) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Study of Slip Gauges along with their usage i.e. wringing of Slip Gauges
2. Study and working of simple measuring instruments: Vernier calipers and micrometer.
3. To study bore gauge diameter with bore gauge.
4. Measurement of angle using sine bar and slip gauges, Study of limit gauges.
5. Study and angular measurement of a given piece using bevel protractor. Study of dial indicator & its constructional details.
6. Measurement of effective diameter of a screw thread using 3 wire method.
7. To measure major diameter, minor diameter and pitch of screw thread using Profile Projector.
8. To measure major diameter, minor diameter and pitch of screw thread using Tool Maker's microscope.
9. To measure the surface roughness using MAHR Pocket Surf instrument.
10. To find the flatness error in surface plate.
11. Study of various equipment(s) viz. Laser Distance measuring device, micro weighing device, sound level meter, etc.

Machine Design-II Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	5	PC	PC	MEC-351
MAE	6	PC	PC	MAC-352

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Machine Design–II) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Teeth, PCDs, module, center distances of all gears and gear ratios within ±2% error.
2. Identification and design of a most heavily stressed gear and selection of material for all gears and shafts of the same gear box.
3. To find the size/diameters of input, output & countershaft as per ASTM recommendations and finding support reactions.
4. To select the bearings for all locations, support & retainment of all shafts using SKF bearing manufacturer's catalogue.
5. To design a double shoe brake for a hoisting mechanism using standard drum sizes and friction materials and check for heat dissipation.
6. To design the bell crank lever, side lever and spring for the designed brake in s.no.5.
7. To design a hook of a crane for hoisting a given load.
8. To design the thrust bearing, bolt size, side plates and central plate for the designed crane hook in s.no.7.
9. To design a connecting rod for an internal combustion engine.
10. To design the big end, small end and cap for the designed connecting rod in s.no.9.

Machine Design-II	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	5	PC	PC	MEC-303

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand relative application suitability of various gears, belt drives and chain drives.
2.	To conceptualise the design needs for differential power requirement in a moving object and the means to achieve them.
3.	To study the various methods of supporting a loaded rotating shaft for diverse applications.
4.	To critically analyse the design needs for wire ropes, crane hooks and engine parts.

Course Outcomes (CO)

CO 1	Analyse the effect of changing speeds on varied power transmission mechanical drives with toothed, chained & flexible elements considering centre distances.
CO 2	Design analysis of mechanisms for stoppage, engagement/disengagement of parts with relative motion in vehicles, machines & hoists.
CO 3	Justify the arrangement for support & retainment of rotating parts at diversified application points containing radial, axial & angular loads with lubrications.
CO 4	Evaluate, Design and select system for transmission at long distances and suitably justify design of Engine parts.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	3	-	-	-	1	1	2	3
CO 2	3	3	2	3	2	-	-	-	2	1	2	3
CO 3	3	3	2	3	2	-	-	-	1	1	2	3
CO 4	3	3	3	3	3	-	-	-	3	1	2	3

UNIT-I

Introduction to Mechanical Drives: Selection criterion of various power transmission drives.
Gear Drive Classification.
Design of **Helical Gears** based on modified Lewis Equation. Dynamic and wear loads. Use in gearbox.
Design of **Bevel Gears**. Dynamic and wear loads.
Design of **Worm & Worm Wheel** Gears. Dynamic and wear loads. Checking for heat dissipation suitability.
Design of **Flat Belt** Drives and Pulleys.

UNIT-II

Friction Clutches and Brakes: Introduction, Classification based on direction of operating Forces. Common Friction Materials.
Clutches Design- Single & Multiple Plate Clutches with uniform pressure and uniform wear theories. Cone Clutch- Design Procedure, Design of Centrifugal Clutch.
Brakes Design: Energy Equations, Single and Multiple Shoe Brake Analysis, Band Brakes.

UNIT-III

Ball & Roller Bearings: Classification &Types, bearing life, Equivalent load, Load-life relationships, Selection of bearings from manufacturer's catalogue based on static and dynamic load carrying capacity. Bearing failures, Bearings with survival probability other than 90%.
Sliding Bearings: Types, Design of journal bearings using McKee's equation, checking bearing suitability, Comparison of rolling and sliding contact bearings, Properties of bearing materials.

UNIT-IV

Hoisting Elements: Introduction to transmission at long distances.
Design procedure of **Wire Ropes**, Classification, designation of wire ropes, Numerical problems.
Design of **Crane Hooks**. Stresses at critical sections.
Introduction to Engine Parts: Design of Piston of I.C Engine and Design of Connecting Rod.

Textbook(s):
1. V.B. Bhandari, "Design of Machine elements", Tata McGraw Hill Education Private Ltd. Third Edition (2012).
2. Maleeve Hartman and O.P.Grover, "Machine Design", CBS Publishers & Distributors, Sixth Edition (2015).

References:
1. Mahadevan, "Design Data Book", CBS Publishers & Distributors.
2. J.E. Shigley & C.R. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Co. Inc.
3. P.C. Sharma and D.K Aggarwal., "Machine Design", S.K. Kataria & Sons.
4. Juvinal R C, Marshek K M, "Fundamentals of Machine Component Design", Wiley India.
5. Norton R. l. "Machine Design" Pearson.

Economics for Engineers	L	P	C
	2		2

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
All	5	HS/MS	HS	HS-301

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To explain the basic micro and macro economics concepts.
2.	To analyze the theories of production, cost, profit and break even analysis.
3.	To evaluate the different market structures and their implications for thebehavior of the firm.
4.	To apply the basics of national income accounting and business cycles toIndian economy.

Course Outcomes (CO)

CO 1	Analyze the theories of demand, supply, elasticity and consumer choicein the market.
CO 2	Analyze the theories of production, cost, profit and break even analysis.
CO 3	Evaluate the different market structures and their implications for thebehavior of the firm.
CO 4	Apply the basics of national income accounting and business cycles toIndian economy.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	1	2	1	2	1	-	1	-	1	1	3	1
CO 2	1	2	1	2	1	-	1	-	1	1	3	1
CO 3	1	2	1	2	1	-	1	-	1	1	3	1
CO 4	1	2	1	2	1	-	1	-	1	1	3	1

UNIT-I

Introduction: Economics Definition, Basic economic problems, Resource constraints and welfare maximization. Microand Macro economics. Production Possibility Curve.Circular flow of economic activities.
Basics of Demand, Supply and Equilibrium: Demand side and supply side of the market. Factors affecting demand & supply. Elasticity of demand & supply – price, income and cross-price elasticity. Market equilibrium price.

UNIT-II

Theory of Consumer Choice: Theory of Utility and consumer's equilibrium.Indifference Curve analysis, Budget Constraints, Consumer Equilibrium.
Demand forecasting: Regression Technique, Time-series, Smoothing Techniques: Exponential, Moving AveragesMethod

UNIT-III

Cost Theory and Analysis: Nature and types of cost, Cost functions- short run and long run, Economies and diseconomies of scale
Market Structure: Market structure and degree of competitionPerfect competition, Monopoly, Monopolistic competition, Oligopoly

UNIT - IV

National Income Accounting: Overview of Macroeconomics, Basic concepts of NationalIncome Accounting
Macro Economics Issues: Introduction to Business Cycle, Inflation-causes,consequences and remedies: Monetary and Fiscal policy.

Textbook(s):
1. H.C. Petersen, W.C. Lewis, Managerial Economics, 4th ed., Pearson Education 2001.

References:
1. S.K. Misra& V. K. Puri, Indian Economy, 38th ed., Himalaya Publishing House, 2020.
2. D.N. Dwivedi, Managerial Economics, 8th Edition, Vikas Publishing house
3. D. Salvatore, Managerial Economics in a Global Economy, 8th ed., Oxford University Press, 2015.
4. S. Damodaran, Managerial Economics, 2 nd ed., Oxford University Press, 2010.
5. M. Hirschey, Managerial Economics, 12th ed., Cengage India, 2013.
6. P.A. Samuelson, W.D. Nordhaus, S. Nordhaus,Economics,18th ed., Tata Mc-Graw Hill, 2006.

Principles of Management for Engineers	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
All	6	HS/MS	MS	MS-302

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To describe the functions, roles and skills of managers and illustrate how the manager's job is evolving.
2.	To evaluate approaches to goal setting, planning and organizing in a variety of circumstances.
3.	To evaluate contemporary approaches for staffing and leading in an organization
4.	To analyze contemporary issues in controlling for measuring organizational performance.

Course Outcomes (CO)

CO 1	Examine the relevance of the political, legal, ethical, economic andcultural environments in global business
CO 2	Evaluate approaches to goal setting, planning and organizing in a variety of circumstances.
CO 3	Evaluate contemporary approaches for staffing and leading in an organization
CO 4	Analyze contemporary issues in controlling for measuring organizational performance.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	2	2	1	2	-	2	-	-	1	2	3	2
CO 2	2	2	1	2	-	2	-	-	1	2	3	2
CO 3	2	2	1	2	-	2	-	-	1	2	3	2
CO 4	2	2	1	2	-	2	-	-	1	2	3	2

UNIT-I

Introduction to Managers and Management: Management an Overview: Introduction, Definition ofManagement, Role of Management, Functions of Managers,Levels of Management, Management Skills andOrganizational Hierarchy, Social and EthicalResponsibilities of Management: Arguments for and againstSocial Responsibilities of Business, Social Stakeholders,Measuring Social Responsiveness and Managerial Ethics,Omnipotent and Symbolic View, Characteristics andimportance of organizational culture, Relevance of political,legal, economic and Cultural environments to globalbusiness, Structures and techniques organizations use asthey go international .

UNIT-II

Planning: Nature & Purpose, Steps involved in Planning, Objectives, Setting Objectives, Process of Managing by Objectives, Strategies, Policies & Planning Premises, CompetitorIntelligence, Benchmarking, Forecasting, Decision-Making.

Directing: Scope, Human Factors, Creativity and Innovation,Harmonizing Objectives, Leadership, Types of Leadership,Directing, Managers as leaders, Early LeadershipTheories…Trait Theories, Behavioral Theories, ManagerialGrid, Contingency Theories of Leadership, Directing ...PathGoal Theory, contemporary views of Leadership, CrossCultural Leadership, Leadership Training, Substitutes ofLeadership

UNIT-III

Organizing: Organizing ,Benefits and Limitations-De-Centralization andDelegation of Authority, Authority versus Power,Mechanistic Versus Organic Organization ,CommonOrganizational Designs, Contemporary OrganizationalDesigns and Contingency Factors, The LearningOrganization Nature and Purpose, Formal and InformalOrganization, Organization Chart, Structure and Process,Departmentalization by difference strategies, Line and Staffauthority- Benefits and Limitations-De-Centralization andDelegation of Authority Versus, Staffing,Human ResourceInventory, Job Analysis , Job Description, Recruitment and

UNIT - IV

Controlling: Controlling, Introduction to Controlling System and processof Controlling, Requirements for effective control, Theplanning Contol link, The process of control, types ofcontrol The Budget as Control Technique, InformationTechnology in Controlling, Productivity, Problems andManagement, Control of Overall Performance, Direct andPreventive Control, Financial Controls, Tools formeasuring organizational Performance, Contemporaryissues in control Workplace concerns, employee theft,employee violence

Textbook(s):

1. Tripathi PC. Principles of management. Tata McGraw-Hill Education; 6th Edition 2017.

References:

1. Koontz H, Weihrich H. Essentials of management: an international, innovation, and leadershipperspective. McGraw-Hill Education; 10th Edition 2018.
2. Principles of Management Text and Cases, Pravin Durai , Pearson ,2015
3. Robbins, S.P. &Decenzo, David A. Fundamentals of Management,7th ed., Pearson, 2010
4. Robbins, S.P. & Coulter, Mary Management; 14 ed.,Pearson , 2009

Universal Human Values	L	P	C
	1		1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
All	6	HS/MS	HS	HS-304

Marking Scheme:

4. Teachers Continuous Evaluation: 25 marks

5. Term end Theory Examinations: 75 marks

6. This is an NUES paper, hence all examinations to be conducted by the concerned teacher.

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper.

Course Objectives :

1.	To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2.	To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3.	To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4.	To analyze the value of harmonious relationship based on trust and respect in their life and profession

Course Outcomes (CO)

CO 1	Evaluate the significance of value inputs in formal education and start applying them in their life and profession
CO 2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
CO 3	Examine the role of a human being in ensuring harmony in society and nature.
CO 4	Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	-	-	-	-	-	3	-	3	1	1	-	1
CO 2	-	-	-	-	-	3	-	3	1	1	-	1
CO 3	-	-	-	-	-	3	-	3	1	1	-	1
CO 4	-	-	-	-	-	3	-	3	1	1	-	1

UNIT-I

Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution: The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution

UNIT-II

Understanding Human Being: Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self

UNIT-III

Understanding Nature and Existence: A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self-awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).

UNIT - IV

Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living: Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence

Textbook(s):

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.
2. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.

References:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986.
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers.
8. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
9. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers, Oxford University Press
10. M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Automobile Engineering and Electric Vehicles	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	6	PCE	PCE-1	MEE-306T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the construction and working principle of various parts of an automobile.
2.	To understand the construction and working of clutch, gear box, differential, propeller shaft, joint, etc.
3.	To understand the steering system and suspension system.
4.	To understand the alternative energy sources used as a fuel in automobile.

Course Outcomes (CO)

CO 1	Explain the construction details of chassis, frame, body and I C engine components used in automobile.
CO 2	Understand Transmission system (Clutch, gearbox, differential, etc.) used in automobile.
CO 3	Comprehend various type of steering system and suspension system.
CO 4	Analyze the alternative fuels used in SI and CI engines, and Electric and Hybrid vehicles.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	-	-	3	3	-	2	-	-	3
CO 2	3	3	3	-	-	3	3	-	1	-	-	3
CO 3	3	3	3	-	-	3	3	-	2	-	-	3
CO 4	3	3	3	-	-	3	3	-	2	-	-	3

UNIT-I

Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines-components, function and materials, variable valve timing (VVT).
Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

UNIT-II

Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

UNIT-III

Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

UNIT – IV

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells.
Introduction to EVs, Comparison with Internal combustion Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges Components of Electric Vehicle, Electric Vehicle Powertrain block diagram.
Battery Energy Storage Batteries in Electric and Hybrid Vehicles: Battery Basics, Battery Parameters, Electrochemical Cell Fundamentals.

Textbook(s):

1. Kripal Singh, "Automobile Engineering", 7th ed. Standard Publication, New Delhi, (1997).
2. Jain K.K. and Asthana R.B.," Automobile Engineering", Tata McGraw Hill, New Delhi, (2002).
3. Iqbal Husain , "Electric and Hybrid Vehicles Design Fundamentals", CRC Press.

References:

1. Heisler H., "Advanced Engine Technology", SAE International Publ., USA, (1998).
2. N. K. Giri, "Automobile Mechanics", 5th Edition, Khanna Publishers, (2014).
3. Narang G.B.S., "Automobile Engg.", Khanna Publishers.
4. Srinivasan, "Automotive Engines", Tata McGraw Hill.
5. Heitner J., "Automotive Mechanics", 2nd ed., East-West Press, (1999).

Automobile Engineering and Electric Vehicles Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	6	PCE	PCE-1	MEE-306P

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Automobile Engineering and Electric Vehicles) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To Study and Demonstration of different Automobile Engines (disassemble and assemble of any Engine).
2. To study and demonstration of the Fuels supply systems (Carburetor, Diesel Fuel Injection Systems and Gasoline Fuel Injection Systems).
3. To study and demonstration of differential used in automobile.
4. To study the constructional details, working principles and operation of the Automotive Clutches.
5. To study the construction details, working principle, operation and demonstration the different types of gearbox used in Automobile.
6. To study and demonstration the different types of Steering Mechanism.
7. To study the constructional details, working principles and operation of the Automotive Suspension Systems.
8. To study the constructional details, working principles and operation of the Automotive Brake systems.
9. To study the constructional details, working principles and operation of the Automotive Tyres& wheels.
10. To Study on advanced technologies (ABS, EBD, VVT and Hybrid).
11. To study the characterization of power, torque and efficiency for EV over drive cycle.
12. To understand the flow of energy in the power train of EV during various modes of operation i.e. charging, V2G feeding, motoring and braking.
13. To conduct specific gravity test and open voltage test of the given battery used in automobile and find the state of charge.
14. To study the basics of induction motor used in EV's.

Power Plant Engineering	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	6	PCE	PCE-2	MEE-318T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To make the students familiar with the properties of coal and its firing methods.
2.	To make the students understand about the various components of steam power plant.
3.	To teach the students the working of Nuclear and hydraulic power plant.
4.	To learn about instrumentation and control system in steam power plant.

Course Outcomes (CO)

CO 1	To learn the properties of coal and its firing methods.
CO 2	To understand the working of Boiler its mountings and accessories and need of combined cycle.
CO 3	To understand working of Nuclear power plant and hydraulic power plant.
CO 4	To acquire the importance of instrumentation and control system in steam power plant

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	2	2	2	-	1	-	-	-	-	2
CO 2	3	2	2	2	2	-	1	-	-	-	-	2
CO 3	3	2	2	2	2	-	2	-	-	-	-	2
CO 4	3	2	2	2	2	-	2	-	-	-	-	2

UNIT – I

Coal fired Power Plants: Indian energy scenario, Indian coals: formation, properties, analysis, calculation of heating value of coals; coking and non-coking coals, fuel handling systems; coal gasification. Classification of power plants, base load and Peak load power stations, co-generated power plant, captive power plant, and their fields of application. coal pulverization, pulverized fuel firing system, combustion process, need of excess air, cyclone furnace, fluidized bed boiler

UNIT – II

Steam Generators: High pressure utility boiler, natural and forced circulation, Boiler mountings and accessories its function and working, placement of evaporator, economizers, super heaters, re-heaters, air pre-heater in the boiler, de-aeration, boiler blow- down, ash collection by bag house, gravity separation, electrostatic precipitators and wet scrubbers, boiler efficiency calculations, water treatment: external and internal treatment

Combined Cycle Power Plants: Binary vapour cycles, coupled cycles, gas turbine- steam turbine power plant. Combined cycle with and without supplementary firing.

UNIT – III

Other power plants: Nuclear power plants - working and types of nuclear reactors, boiling water reactor, pressurized water reactor, fast breeder reactor, controls in nuclear power plants, hydro power plant - classification and working of hydroelectric power plants, tidal power plants, diesel and gas power plants.

UNIT – IV

Instrumentation and Controls in power plants: Important instruments used for temperature, flow, pressure, water/steam conductivity measurement; flue gas analysis, drum level control, combustion control, super heater and re-heater temperature control, furnace safeguard and supervisory system (FSSS), auto turbine run-up system(ATRS), interlocks and protection of turbines.
Environment Pollution and Energy conservation: Economics of power generation: load duration curves, power plant economics, pollution from power plants, disposal/management of nuclear power plant waste

Textbooks:

1. Power Plant Engineering by M.M. Elwakil, Tata McGraw Hill.
2. Power Plant Engineering by P.K Nag, Tata McGraw Hill.

References:

1. Steam and Gas turbines by A Kostyuk and V Frolov, MIR Publishers, ISBN9785030000329.
2. Modern Power Plant Engineering by J Wiesman and R Eckart, Prentice hall India Ltd, ISBN- 97801359725.
3. Applied Thermodynamics by T.D Eastop and McConkey, Longman Scientific and Technical, ISBN-0582305351.

Power Plant Engineering Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	6	PCE	PCE-2	MEE-318P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Power Plant Engineering) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To study and Simulate Boiler Internals.
2. To study and simulate Superheater and Reheaters.
3. To study and simulate Regenerative Feed Water Heaters.
4. To study and Simulate Turbine Vaccum system.
5. To draw Heat Balance sheet of a Boiler.
6. To study the working of Gas Turbine Cycle.
7. To study Combined Cycle and determine effect of Pressure ratio on thermal efficiency.
8. To conduct performance test on four-stroke diesel engine.
9. To conduct performance test on four-stroke petrol engine.
10. To conduct performance test on hydraulic power plant.
11. To determine dryness fraction of given steam sample.
12. To study working of Nuclear Power Plant.
13. Visit to thermal/Hydraulic/Nuclear Power Plant.

Metal Forming and Press Working	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	6	PCE	PCE-3	MEE-332T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the concept of different metal forming process.
2.	To understand the metal forming processes both analytically and numerically.
3.	To Design various elements of metal forming processes.
4.	To develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

Course Outcomes (CO)

CO 1	Understand the concept of different metal forming process.
CO 2	Approach metal forming processes both analytically and numerically.
CO 3	Design various elements of metal forming processes.
CO 4	Develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	-	2	-	-	-	-	-	2
CO 2	3	3	3	3	-	3	-	-	-	-	-	2
CO 3	3	3	3	3	-	3	-	-	-	-	-	2
CO 4	3	3	3	2	-	3	-	-	--	-	-	2

UNIT-I

Introduction to Metal Forming: Classification of metal forming processes, advantages and limitations, stress-strain relations in elastic and plastic deformation. Concepts of true stress, true strain, triaxial& biaxial stresses. Determination of flow stress, principal stresses, yield criteria and their significance, Tresca & Von-Mises yield criteria, concepts of plane stress & plane strain. Deformation mechanisms, Hot and Cold working processes and its effect on mechanical properties. Simple numerical problems.

Effects of Parameters: Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, Effects of Temperature, strain rate, friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, and Residual stresses in wrought products. Simple numerical problems.

UNIT-II

Forging: Classification of forging processes. Forging machines equipment. Expressions for forging pressures & load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it. Die-design parameters. Material flow lines in forging, forging defects, residual stresses in forging. Simple numerical problems.
Rolling: Classification of rolling processes. Types of rolling mills, expression for rolling load. Roll separating force. Frictional losses in bearing, power required in rolling, effects of front & back tensions, friction, friction hill. Maximum possible reduction. Defects in rolled products. Rolling variables. Simple numerical problems.
Drawing: Drawing equipment& dies, expression for drawing load by slab analysis, power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, Tube drawing, classification of tube drawing. Simple numerical problems.

UNIT-III

Extrusion: Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, extrusion of seamless tubes. Extrusion variables. Simple problems.
Sheet Metal Forming: Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming. Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, LDR in drawing, forming limit criterion, defects of drawn products, stretch forming. Roll bending & contouring. Simple problems.

UNIT-IV

High Energy Rate Forming Methods & Powder Metallurgy: High Energy Rate Forming Methods: Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic forming.
Powder Metallurgy: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations.

Text books:

1. Amithab Gosh & A.K.Malik, “Manufacturing Science”, East-West press 2001.
2. O. P. Khanna & Lal,” Production Technology Vol-II “, Dhanpat Rai Publications-2012.

Reference Books:

1. E.Paul, Degramo, J.T.Black, Ranold, A.K “.Materials & Process in Manufacturing”, PHI, 2002.
2. S.K.Hajra Choudhury,” Elements of Workshop Technology Vol 1”, Media Promoters & Publishers, 2008.
3. Lal G K,”Fundamentals of Manufacturing Processes” , Narosa.
4. P. C. Sharma,” Textbook of Production Engineering”, S Chand & Company Ltd.
5. 2. R.K Jain, Production “Technology (Manufacturing process technology and Automation”, Khanna Publishers-2004.
6. G.E.Dieter, “Mechanical metallurgy (SI Units)”, McGraw hill Pub-2001.
7. B.S Raghuwanshi, “A Course in Workshop Technology Vol: 1”, Manufacturing Process, Dhanpat Rai, 2014.

Metal Forming and Press Working Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	6	PCE	PCE-3	MEE-332P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Metal Forming and Press Working) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To Study the general safety rules for metalworking operations
2. To carry out cold rolling of nonferrous metal and study its effect on properties
3. To determine the coefficient of interfacial friction during plastic deformation of metals by means of compression of a ring between two compression platens.
4. To carry out the hot rolling process
5. To make rod/pipe/falt sheet bending using Mechanical/Hydraulic press (or) to perform Bending Operation and calculate bending force.
6. To draw an Aluminum wire of Ø3.35mm from Ø 9.50mm Rod
7. To study the deep drawing process.
8. To learn the forming characteristics of sheet metal specimens with Deep Drawing operation.
9. To carry out the Extrusion process
10. To examine the microstructure of rolled, forged, extruded and drawn parts
11. To carry out the Forging process

Supply Chain Management	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	6	QM-EAE	QM-EAE-1	QM-326T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand about different types of building blocks of a supply chain network.
2.	To understand the supply chain strategy and performance measures and supply chain integration.
3.	To understand network designing and operation in supply chain and forecasting techniques.
4.	To understand about supply chain restructuring.

Course Outcomes (CO)

CO 1	Develop a sound understanding of the important role of supply chain management in today's business environment.
CO 2	Apply foundational business skills needed in SCM settings.
CO 3	Analyse the analytical business skills to address SCM challenges.
CO 4	Understand and apply the current supply chain theories, practices and concepts utilizing case problems and problem-based learning situations.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	-	2	-	-	-	-	-	3
CO 2	3	3	3	3	-	3	-	-	-	2	-	3
CO 3	3	3	3	3	-	3	-	-	-	2	-	2
CO 4	3	3	3	2	-	3	-	-	2	2	-	2

UNIT-I

Introduction: Evolution of SCM, Building blocks of a supply chain network. Decision in a Supply Chain; Strategic, tactical, and operational decisions, SCM in Indian Context.
Supply chain Strategy and performance measures: Customer service and cost trade- off; order delivery lead time; supply chain responsiveness; delivery reliability, product variety; Benchmarking supply chain performance using financial data. Supply chain optimization, integration and restructuring.

UNIT-II

Supply chain inventory management: Types of Inventory, inventory related costs, managing cycle stock, managing safety stock, managing seasonal stock, Supply chain redesign on the inventory, Inventory of short life cycle products. Newsboy, Base-stock, and (Q,r) models, multi-echelon supply chains, Performance modelling of supply chains using Markov chains and queuing networks.

Modes of transportation: choice and their performance measure, Vehicle Scheduling, Transportation costs in E retailing.
Network designing and operation: planning for network operations, design of networks, Data for network design, location of Service outlets.

UNIT-III

Demand forecasting: Qualitative forecasting methods, Quantitative Forecasting methods, Time series forecasting models.
Web based SCM: Internet-enabled supply chains: e-marketplaces, e-procurement, elogistics, customer relationship management, web services, supply chain automation, and supply chain integration.
Supply chain Integration: Internal and External, Building relationship and trust; Vendor management, customer response.

UNIT - IV

Supply chain Restructuring: Value addition curve, Entry point of customer, Supply chain mapping, point of differentiation, Postponing for cost reduction, Change in the value addition curve.
Agile Supply chain, Pricing and revenue management.

Textbook(s):

1. Janat Shah, "Supply Chain Management: Text and Cases", Pearson Education India, 2009.
2. Sunil Chopra, "Supply Chain Management, 3rd Ed", Pearson Education India, 2009.

References:

1. Khanna O. P., "Industrial Engineering Management".

Supply Chain Management Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	6	QM-EAE	QM-EAE-1	QM-326P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Supply Chain Management) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To conduct experiment regarding building blocks of a supply chain network.
2. To perform decision in a Supply Chain; Strategic, tactical, and operational decisions using case study.
3. To conduct benchmarking supply chain performance using financial data.
4. To conduct supply chain inventory management with case study.
5. To calculate Performance modelling of supply chains using Markov chains and queuing networks.
6. To perform network designing and operation with data for network design.
7. To prepare demand forecasting with any given data and using appropriate method.
8. To perform Web based SCM.
9. To determine Supply Chain Restructuring.
10. To determine Pricing and revenue management with any given data.

Flexible Manufacturing Systems	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	6	QM-EAE	QM-EAE-2	QM-328T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To study different aspects of Flexible Manufacturing System and determine difference between traditional manufacturing system and Flexible Manufacturing System.
2.	To understand different components of Computer Integrated Manufacturing System with its importance in modern manufacturing environments pertaining to managing different projects.
3.	To understand how Automated Material Movement is achieved through the use of AGV, ATC and ASRS and its importance as an integral part of Flexible Manufacturing System.
4.	To understand how Artificial Intelligence and Computer Aided Quality Control helps Flexible Manufacturing System works effectively.

Course Outcomes (CO)

CO 1	Analyse different aspects of Flexible Manufacturing System and determine difference between traditional manufacturing system and Flexible Manufacturing System.
CO 2	To analyse and explain different components of Computer Integrated Manufacturing System with its importance in modern manufacturing environments pertaining to managing different projects.
CO 3	To analyse and explain how Automated Material Movement is achieved through the use of AGV, ATC and ASRS and its importance as an integral part of Flexible Manufacturing System.
CO 4	To Evaluate how Artificial Intelligence and Computer Aided Quality Control helps Flexible Manufacturing System works effectively.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	2	-	2	-	-	-	-	-	2
CO 2	3	3	3	2	-	2	-	-	-	-	-	2
CO 3	3	3	3	2	-	2	-	-	-	-	-	2
CO 4	3	3	3	2	-	2	-	-	--	-	-	2

UNIT I

Introduction and Definition: Flexible Automation and Manufacturing Cell and Flexible Manufacturing System. Flexible Automation and Manufacturing systems and its productivity, History of FMS systems, definition, concept, benefits, problems in batch production, Types of FMS, Components of FMS, control of workstation, AGV systems, Functions of FMS, Scheduling and loading FMS, Layout configurations for FMS, communication in FMS, simulation in FMS, Installation and examples of FMS, optimization of FMS, typical layout of FMS, The FMS software. Feasibility report of FMS, advanced control cycle of FMS.

UNIT II

CIM System: Introduction to CAD & CAM and its tools, Concept and origin of CIM, components of CIM, Emerging technologies of CIM, computer control system, sensing and identifying for manufacturing, CIMS data files, factors affecting performance, advantages and limitations, performance evaluation of a CIM system. Human centered CIM system, CIM technology in manufacturing environments, Factory information system, Sequential and concurrent engineering.

UNIT III

High Volume Production System: Types of Automated assembly systems, Automated production or transfer lines, Equipment and arrangement of transfer lines, methods of work transport, transfer mechanisms, Assembly line balancing, numericals on line balancing, computerized line balancing methods.
Automated Material Movement: Function, Types of material movement systems, material movement through conveyors, material movement through robots, material movement through AGVs, automated guided vehicle operation and control, Advantages and limitations of AGVs, economic considerations.
Automatic tool changer (ATC), Storage and automated production line, Automated storage and retrieval system (ASRS), Carousel storage system, In-process storage system, communication with material in storage and in movement.

UNIT IV

Introduction to artificial intelligence in manufacturing automation, expert systems, AI programming for expert systems.
Computer Aided Quality Control: CNC 3D Coordinate Measuring machines, TQM, QC & CIM, Inspection and Testing, SPC, Role of computers in QC, Non contact inspection methods, Post process Metrology, Computer aided inspection using robots, integration of CAD / CAM with inspection system, Flexible Inspection system, Reverse Engineering.

Textbook(s):
1. P Radhakrishnan, S subramanym, V Raju; CAD/CAM/CIM; New Age International Publishers.
2. K.C. Jain, Sanjay Jain, Principles of Automation and Advanced Manufacturing systems, Khanna Publications.

References:
1. Ibrahim Zeid, R Sivsubramanian, CAD/ CAM Theory & Practice, MCGraw Hill.

Flexible Manufacturing Systems Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	6	QM-EAE	QM-EAE-2	QM-328P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Flexible Manufacturing Systems) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Develop programs on CNC lathe.
2. Develop programs on CNC milling.
3. Study and operate a Coordinated Measuring Machine and 6 axis robot.
4. Study working of a Flexible manufacturing system.
5. Operate FMS with automatic storage and retrieval, conveyor, lathe, robot milling machine.
6. Simulation of CIM and scheduling problem 1 on CIM Software (such as ER-Virtual / any other).
7. Simulation of CIM and scheduling problem 2 on CIM Software.
8. Simulation of CIM and scheduling problem 3 on CIM Software.

Principles of Entrepreneurship Mindset	L	P	C
	2		2

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
All	7	HS/MS	MS	MS-401

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand basic aspects of establishing a business in a competitive environment
2.	To apply the basic understanding to examine the existing business ventures
3.	To examine various business considerations such as marketing, financial and teaming etc.
4.	To assess strategies for planning a business venture

Course Outcomes (CO)

CO 1	Understand basic aspects of establishing a business in a competitive environment
CO 2	Apply the basic understanding to examine the existing business ventures
CO 3	Examine various business considerations such as marketing, financial and teaming etc.
CO 4	Assessing strategies for planning a business venture

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	2	2	1	2	-	2	-	-	1	2	3	2
CO 2	2	2	1	2	-	2	-	-	1	2	3	2
CO 3	2	2	1	2	-	2	-	-	1	2	3	2
CO 4	2	2	1	2	-	2	-	-	1	2	3	2

UNIT-I

Entrepreneurial perspective: Foundation, Nature and development ofentrepreneurship, importance of entrepreneurs,Entrepreneurial Mind, Individual entrepreneur Typesof entrepreneurs, Entrepreneurship in India

UNIT-II

Beginning Considerations: Creativity and developing business ideas; Creatingand starting the venture; Building a competitiveadvantage; Opportunity recognition, Opportunityassessment; Legal issues

UNIT-III

Developing Financial Plans: Sources of Funds,Managing Cash Flow,Creating a successful Financial PlanDeveloping a business plan

UNIT - IV

Developing Marketing Plans: Developing a powerful Marketing Plan, E-commerce,Integrated Marketing Communications
Leading Considerations: Developing Team, Inviting candidates to join team,Leadership model

Textbook(s):

1. Robert D Hisrich, Michael P Peters & Dean A Shepherd, "Entrepreneurship" 10th Edition,McGraw Hill Education, 2018

References:

1. Norman M. Scarborough and Jeffery R. cornwell, "Essentials of entrepreneurship and small business management" 8th Edition, Pearson, 2016
2. Rajiv Roy, "Entrepreneurship", 2nd Edition, Oxford University Press, 2011
3. Sangeeta Sharma, "Entrepreneurship Development", 1st Edition, Prentice-Hall India, 2016
4. John Mullins, "The New Business Road Test: What entrepreneurs and investors should dobefore launching a lean start-up" 5th Edition, Pearson Education, 2017
5. Charantimath, Entrepreneurship Development and Small Business Enterprise, Pearson Education.

Automation in Manufacturing	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	7	PCE	PCE-4	MEE-411T
MAE	7	OAE-MAE	OAE-1	MAO-415T
OAE	7	ME-OAE	ME-OAE-5	OME-443T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand about the fundamental concepts, the necessary knowledge and the basic skills related to automated manufacturing systems.
2.	To understand the techniques of Machine Tool Automation and NC systems.
3.	To understand working principle of different CNC Machine Tools.
4.	To provide an introduction to Robotics and Automation including robot classification, design and selection, analysis and applications in industry.

Course Outcomes (CO)

CO 1	To Provides theoretical and practical aspects of implementing automation in industry.
CO 2	To Understand the basic procedures and concepts of programming, set up and operation of a CNC Machining Centre.
CO 3	To Identify and define the functions of the CNC machine control.
CO 4	To understand basic components of robotics, classification of robots and their applications

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	-	2	-	-	-	-	-	2
CO 2	3	3	3	3	-	3	-	-	-	2	-	2
CO 3	3	3	3	3	-	2	-	-	2	2	-	3
CO 4	3	3	3	2	-	3	-	-	2	2	-	3

UNIT-I

Introduction: Concept of Mechanization and Automation; Need philosophy; basic elements; classification of automated manufacturing systems [hard, programmable and flexible automation]; strategies for automation in production systems; on line condition monitoring of automated systems, Level of automation.

Parts handling automation: Basic concepts of chute, magazine, hopper, separator, feeders, ejectors, orienters and transfer machines

UNIT-II

Machine tool automation: Single and multi-spindle automats, Swiss type automats and design of automat for a specific product.
Basic principles of NC system: Components and their functions in NC machines; MCU, DPU and CLU; drives; special motors and screw-nut system; advantages of CNC over NC machines; Basic systems of NC and CNC machines: coordinate system, open loop and closed loop control; absolute and incremental mode.

UNIT-III

CNC machine tools: structure and working principle; examples and use of CNC machines; machining centre (MC) – characteristics and applications; Control of tool–work travel; PTP and Continuous; interpolation – linear and circular
Part programming for NC, CNC and MC systems: Manual part programming: different controllers and codes used; sequential steps of part programming; examples: part programming for machining in CNC lathes [step turning, taper turning, grooving, thread cutting, drilling, boring, facing, contouring etc. and milling [pocketing, island pocketing, grooving, peck drilling

UNIT – IV

Introduction to Robotics: Brief history of robotics; definition of robot; Main components of robot: manipulator, sensors, controller, power conversion unit; Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, joined; Classification of robot according to coordinate system: Cartesian, cylindrical, polar, articulated or jointed; Classification of robots according to control method: non-servo, servo; Robot specifications: payload, accuracy, repeatability resolution, maximum tip speed, reach stroke.

Textbook(s):
1. Automation, Production Systems and CIM–M.P.Groover, Pub- Prentice-Hall of India (P) Ltd.New Delhi
2. Fundamentals of Industrial Automation by V Tergan, I Andreev and B. Liberman, MIR Publisher.

References:
1. CNC Machines by N. K. Tewari, Kundra and P. N. Rao.
2. Introduction to Robotics by J. J. Craig, Addison-Wesley.
3. Computer Control of Manufacturing Systems by Y. Koren, Tata Mc Graw Hill.

Automation in Manufacturing Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	7	PCE	PCE-4	MEE-411P
MAE	7	OAE-MAE	OAE-1	MAO-415P
OAE	7	ME-OAE	ME-OAE-5	OME-443P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Automation in Manufacturing) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To study CNC Lathe and CNC Mill
2. To develop programs on CNC Lathe
3. To develop programs on CNC milling
4. To study working of a Flexible manufacturing system
5. To prepare APT program for the given diagram.
6. To prepare APT program for the given diagram.
7. To study working principle of Robotic Arm.
8. To operate perform Pick and Place task using Robotic Arm

Total Quality Management	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	QM-EAE	QM-EAE-3	QM-441T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand the concept of Quality.
2.	To understand the Implication of Quality on Business.
3.	To Implement Quality Implementation Programs.
4.	To have exposure to challenges in Quality Improvement Programs.

Course Outcomes (CO)

CO 1	Evaluate the usage of TQM as an essential tool for quality improvement.
CO 2	Review therole of leadership, performance appraisal and supplier partnership as the important strategies in the field of TQM.
CO 3	Examine seven traditional tools used for enhancing the quality of a system.
CO 4	Estimate and compare the various ISO 9000- ISO 9000-2000, ISO 14000 Quality Systems.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	-	2	-	-	-	-	-	-	2	-	-
CO 2	3	2	2	2	2	2	-	2	2	-	-	-
CO 3	3	3	3	3	3	-	-	-	-	-	-	2
CO 4	3	-	2	-	2	3	2	-	--	-	-	-

UNIT-I

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

UNIT-II

TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

UNIT-III

The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.
TQM tools and techniques, control charts, process capability, concepts of six sigmas, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

UNIT - IV

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

Textbook(s):

1. Bester field D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Janaki Raman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.

References:

1. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
2. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Total Quality Management Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	QM-EAE	QM-EAE-3	QM-441P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Total Quality Management) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To perform Quality considerations in design.
2. To understand difference between product quality and service quality with case study.
3. To calculate costs to quality of a given specimen.
4. To perform PDCE cycle of a case study.
5. To study Six sigma- concepts, methodology.
6. To apply TQM tools and techniques on case study.
7. To construct control charts on given data.
8. To calculate Taguchi quality loss function.
9. To study seven traditional tools of quality and their application.
10. To study TQM implementation in manufacturing and service sectors with case study.

Non Traditional Manufacturing	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	7	PCE	PCE-5	MEE-423T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To Understand the classifications of non-traditional machining processes based on industrial applications.
2.	To describe the working of modern machining methods based on mechanical, chemical, thermal and thermo-electric energy.
3.	To explain, how to investigate the of process parameters of advanced machining methods on its characteristics.
4.	To describe the effects of process parameters numerically, on the performance of Non-traditional methods.

Course Outcomes (CO)

CO 1	Explain Categories of non- traditional machining processes based on industrial applications.
CO 2	Analyse the working principle of modern machining methods based on mechanical, chemical, thermal and thermo-electric energy.
CO 3	Carryout the investigation of process parameters of advanced machining methods on its characteristics.
CO 4	Evaluating the effects of process parameters (numerically) on the output parameters of Non-traditional methods.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	3	-	2	-	-	-	-	-	2
CO 2	3	3	3	3	-	3	-	-	-	-	-	2
CO 3	3	3	3	3	-	3	-	-	-	-	-	2
CO 4	3	3	3	2	-	3	-	-	--	-	-	2

UNIT I

Introduction: An overview of Modern Manufacturing Methods (MMM) - Classification, their comparative study, Need of MMM.

Process Selection: Physical Parameters, Shape applications, Material applications, Process capability, Effects on equipment and Tooling, Process economy.

UNIT II

Electric Discharge Machining: Working Principle, Mechanism of metal removal, Basic EDM circuits, selection of tool material and dielectrics, Flushing, Advantages, Disadvantages and Applications, Wire-cut EDM.
Ultrasonic Machining: Construction and working Principle, Elements of Process, Effect of process parameters, Applications and limitations.
Abrasive Jet Machining: Working Principle, equipment used, Variables in AJM, Advantages, Disadvantages, Application.
Water Jet Machining: Working Principle, equipment used, process parameter, Advantages, Disadvantages, Application.

UNIT III

Electro Chemical Machining (ECM): Principle, Elements of ECM process, Electrochemistry of ECM, selection of electrolytes and analysis of ECM, Advantages, Limitations, Applications.
Electro Chemical Grinding (ECG): Process: Working principle, equipment used, Process parameters, Advantages, Disadvantages and Applications.
Electro Chemical Honing (ECH): Process: Working principle, equipment used, Process parameters, Advantages, Disadvantages and Application.

UNIT IV

Laser Beam Machining: Working principle, equipment, Process parameters, Advantages, Disadvantages and Application.
Plasma Arc Machining: Working Principle, Parameters, Safety precautions, Applications.
Electron Beam Machining: Principle, beam control techniques, Process capabilities, Comparison of thermal and non-thermal processes, Advantages and limitations.

Textbooks:
1. P.C. Pandey & H.S. Shan, “Modern Machining Process”, Tata McGraw Hills, 2006.
2. Amitabh Gosh and A.K. Mallik, “Manufacturing Science”, Affiliated East-West Press Pvt. Ltd., 1985.

References:
1. Vijay K Jain, “Advance Machining Processes”, Allied Publishers Pvt. Ltd., New Delhi, 2002.
2. P K Mishra, “Nonconventional Machining”, Narosa Publication, 1997.
3. McGeough, “Advanced Methods of Machining”, Chapman and Hall, London, 1998.

Non Traditional Manufacturing Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ME	7	PCE	PCE-5	MEE-423P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Non Traditional Manufacturing) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Study of electric discharge machining process.
2. Determination of material removal rate on electric discharge machine (EDM).
3. Determination of surface roughness on EDM.
4. Study of electrochemical machining process.
5. Determination of material removal rate on electro chemical machine (ECM).
6. Determination of surface roughness on ECM.
7. Study of Flexible manufacturing system.
8. Case study of Rapid Prototyping
9. Study the effect of current on material removal rate in EDM.
10. Determine the effect of different tool material on material removal rate in EDM.
11. Determine the effect of current on surface finish rate in EDM.
12. Determine the effect of different tool surface finish on surface finish in EDM.

Statistical Quality Control	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	QM-EAE	QM-EAE-4	QM-443T

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To understand and utilize the tools of quality systems.
2.	To collect, analyse and plot variable and attribute data. Create and react to control charts.
3.	To understand and monitor sources of variation.
4.	Determine and use capability indices to describe a process.

Course Outcomes (CO)

CO 1	Evaluate the usage of Statistical analysis tools as an essential tool for quality improvement.
CO 2	Collect, analyse and chart attribute data parameters.
CO 3	Measure and describe process capability.
CO 4	Setup and use various chart types for problem solving.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	-	2	-	-	-	-	-	-	2	-	-
CO 2	3	2	2	2	2	2	-	2	2	2	-	-
CO 3	3	3	3	3	3	-	-	-	-	-	-	2
CO 4	3	-	2	-	2	3	2	-	2	-	-	2

UNIT-I

The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement).
Mean, Median, Mode, Standard deviation, calculating area, The Deming funnel experiment, Normal distribution tables, Finding the Z score, Central limit theorem.

UNIT-II

Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL).

UNIT-III

Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. Simple Numerical Problems.
Statistical Process Control and Process Capability, Zero defect programme; Six – Sigma approach.

UNIT – IV

The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Military Standard 105E, the Dodge-Romig sampling plans. Numerical problems

Textbook(s):

1. M. Mahajan, Statistical Quality Control, Dhanpant Rai and Co.
2. Grant and Leavenworth-Statistical Quality Control, 7th Edition, Tata Mcgraw Hill.

References:

1. D.C. Montgomery, Introduction to Statistical Quality Control, John Wiley, 2019.
2. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Juran's Quality Control Handbook –McGraw Hill Book Company.

Statistical Quality Control Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EAE	7	QM-EAE	QM-EAE-4	QM-443P

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Statistical Quality Control) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To verify given statistical relationships.
2. To plot and determine the given unknown distribution.
3. To plot control charts for X-Bar and R- Charts.
4. To perform use of control charts and process engineering techniques for implementing thequality plan.
5. To state and prove central limit theorem.
6. To perform statistical tolerance analysis of case study.
7. To perform sampling problem of a given data.
8. To design a sequential sampling plan.
9. To study Six sigma quality tools and its application.
10. To study quality function and concept of quality cycle.