Syllabus for

B.Tech in MECHANICAL ENGINEERING

3rd Semester to 8th semester

(to be effective from 2016-17 admission batch)

Autonomy Curriculum and Syllabus of B.Tech Programme
Implemented from the Academic Year 2016

SEMESTER III

Name of the Course: Applied Thermodynamics,

Course Code: ME 301

Course Objectives: To analyze all relationships of heat and work transfer and develop detailed knowledge of vapour and gas power systems.

Course Outcomes:

Upon successful completion of this course the student will be able to:

1. Understand the second law limitation of thermodynamic efficiencies and sort out realistic and unrealistic thermodynamic system claims.
2. Become enlightened about Entropy and Exergy analysis of thermal systems to check sustainability of practical equipments in industries.
3. Able to analyze the performance variables of vapor power and gas power cycles, evaluate losses and learn the modifications practiced in modern power sectors.
4. Get idea about gas compressors and the basics of Refrigeration & Air Conditioning to apply in real time project works.

Course content

Module No.	**Syllabus**	**Contact Hrs.**
1	Review of fundamentals; Heat and work, First law for unsteady flow system.	2
2	Pure Substance, Properties of pure substance; Phases of pure substances- Phase rule; Phase Change Processes of Pure Substances – triple pt., critical pt.; Property diagrams of Phase change Processes; P-V-T surface for phase change; Property tables of real substances – compressed liquid, saturated, wet & superheated vapour.	2
3	The 2nd Law of Thermodynamics; the corollaries & their proofs; the property of	3

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME301.1	3	2	1	2	-	1	1	1	-	-	1	1	2	1	1
ME301.2	2	2	2	3	-	1	2	1	-	-	1	1	2	1	1
ME301.3	3	3	2	3	-	2	2	-	-	-	1	1	3	3	2
ME301.4	2	3	2	2	-	2	2	-	-	-	2	1	3	2	3
Avrg.	**2.5**	**2.5**	**1.75**	**2.5**		**1.5**	**1.75**	**0.5**			**1.25**	**1**	**2.5**	**1.75**	**1.75**

Course Name: Strength of Materials,

Course Code: ME 302

Total Contact Hours: 34

Credits: 3

Pre requisites:

Course Objectives: To impart detailed knowledge on material strength while subjected to various stress and strain in mechanical bodies.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Apply knowledge of mathematics in analyzing tensile and compressive strength as well as understanding compound stresses developed in a material.
2. Learn the calculation of shear force and bending moment for designing system components to meet desired characteristics from economic, environmental and societal considerations.
3. Use the knowledge of calculating beam stresses for a safe and sustainable design application and apply in constructive projects.
4. Understand the effect of torsion on beams and columns for a variety of loading conditions which boosts industrial skills.

Course content

Module No.	Syllabus for Autonomy	Number of lectures
1	***Simple Stress & Strain*** Concept of rigid body mechanics, General meaning of Stress, Simple Stress, **Normal Stress & True Stress, unit of Stress,Shear Stress, Shear Stain,**	8

	Hook's Law, Stress- **Stain Diagram, Elastic Constant, Poison's ratio, Ba**rs width, Cross section Varying in steps & Bars with continuously varying Cross section,Compound Bar.Volumetric Strain, Relation between modulus of elasticity & Modulus of rigidity, Relation between modulus of elasticity & Bulk Modulus. Stain Energy due to direct Stress and impact load, Stain Energy due to Shear Stress, Compound Stress	
2	Bi axial stress, Mohr's circle, Subjected unidirectional direct & Bi-axial direct stress.Stress in thin wall pressure vessels, longitudinal & hoop stress, its relations	4
3	Shear force and Bending Moment in statically determinate beam Shear force and Bending Moment, sign convention, relationship Between load intensity sheer force and bending moment, shear Force and bending moment diagram SFD and BMD for standard cases a) Cantilever subjected to a central concentrated load b) Cantilever subjected to a uniformly distribute load (UDL) c) Cantilever subjected to a uniformly varying load (UVL) Simply Supported Beam a) Simply Supported Beam subjected to a central concentrated load b) Simply Supported Beam subjected to a uniformly distribute load (UDL)	7

	c) Simply Supported Beam subjected to an external moment at a distance x. d) Over hanging Beam subjected to a concentrated load at free ends	
4	Stresses in Beam Theory of Simple Bending, assumptions in Simple theory of bending, Relationship between bending stress & radius of curvature, Relationship between moment & radius of curvature, Moment Carrying capacity of a section of uniform strength, Leaf Spring, shear stress in beam of few standard sections,Rectangular section, Built up section	5
5	Torsion Introduction Pure torsion, Assumptions in the theory of pure torsion Derivation of torsional equation, Polar moment, power Transmission, torsional rigidity, Stiffness of shaft, Stepped Shaft and compound shaft, coupling, Strain energy in torsion, Closed coil helical spring	5
6	Columns and struts Short column, long column subjected to a axial load Euler's theory for axial loaded elastic long column for a) Both end hinged, b) One end hinged and other end free c) Both end fixed, d) one end fixed other end hinged, Effective length, Limitations of Euler's theory, Rankine's formula	5

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME302.1	3	2	1	1	-	2	2	-	-	-	1	2	2	1	2
ME302.2	3	3	2	2	-	3	3	1	-	-	2	2	2	-	3
ME302.3	2	3	2	2	-	3	2	2	-	-	1	2	2	-	2
ME302.4	2	2	2	2	-	2	2	1	-	-	1	2	2	-	-
Avrg.	**2.5**	**2.5**	**1.75**	**1.75**		**2.5**	**2.25**	**1**			**1.25**	**2**	**2**	**0.25**	**1.75**

Course Name: Fluid Mechanics,

Course Code: ME 303

Total Contact Hours: 36

Credits: 3

Pre requisites: Basic fluid mechanics (ME201)

Course Objectives: To introduce and explain fundamentals of Fluid Mechanics which is useful in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics, Heat Transfer, Power Plant etc.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Get an overall idea about fluid flow properties and calculation of hydrostatic forces on flat or curved surfaces.
2. Explore the detailed analysis of kinematics and dynamics of fluid for laminar and turbulent flow and exploit the conservation equations for the flow regimes of practical interest.
3. Learn about boundary layer theory for a variety of constraints and understand the basics of a turbulent flow.
4. Explain the basics of compressible flow and carry out dimensional analysis for practical prototyping.

Module No.	Syllabus	Contact Hrs. / No. of Lectures
1	Introduction: Introduction to Fluid Mechanics - Fluid, Fluid types, Introduction of Viscosity.	01
2	Fluid statics: Forces on submerged surfaces; forces or vertical, horizontal, inclined and curved surfaces, Center of pressure. Stability of floating bodies, Metacentre. Fluid kinematics: fluid flow and classifications. Continuity equation in 1D& 3D. Potential flow	03

	& Stream function; types of flow lines. Dynamics of fluid: equations of motion ; Euler 's equation of motion; Stokes equation ; Bernoulli's equation; Applications of Bernoulli's equation	
3	Viscous flow: Flow through circular pipes, Flow between parallel plates, momentum and energy correction factors Turbulent flow, velocity distribution in turbulent flow through pipes in	03
3	Flow through pipes: Fluid friction in pipes, head loss due to friction. Darcy–Weisbach equation of friction loss; hydraulic grade line and total energy line. Variation of friction factor with wall roughness – Mood 's chart. Minor losses in pipes.	04
4	Orifices, mouthpieces, notches and weirs: Basic principle for through orifices, V-flow through notches (rectangular-v), weirs (rectangular)	03
5	Boundary layer flow: Definition; Boundary layer separation – basic concept. Drag force on a flat plate due to boundary layer, Turbulent layer on a flat plate.	04
6	Forces on submerged bodies: Flow of fluid around submerged bodies; basic concepts of drag and lift.	03
7	Dimensional Analysis and Model studies: Dimensions and dimensional Analysis, Buckingham's Pi theorem with applications. Geometric, Kinematic and Dynamic similarity. Non Dimensional Numbers.	03
8	Compressible Flow: Thermodynamic relations, Basic equations of compressible flow, velocity of pressure wave in a fluid, Mach number, Stagnation properties, area velocity relationship, flow of compressible fluid through orifices and nozzles fitted to a large tank.	04

Text Books

1. Introduction to Fluid Mechanics & Fluid Machines – Som & Biswas, TMH
2. Fluid Mechanics & Machinery – R.K.Bansal, Luxmi Publications
3. A textbook on Fluid Mechanics and Hydraulic Machines – Sukumar Pati, TMH
4. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.

Reference Books

5. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
6. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.
7. Mechanics of Fluid – Bernard Massey, Taylor & Francis.

Course Articulation Matrix:

CO Codes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME303.1	2	2	1	1	-	-	-	-	-	-	-	-
ME303.2	3	3	2	2	-	-	-	-	-	-	-	1
ME303.3	3	2	1	2	-	-	-	-	-	-	-	1
ME303.4	2	2	1	1	-	-	-	-	-	-	-	1
Avrg.	**2.5**	**2.25**	**1.25**	**1.5**								**0.75**

Course Name: Mathematics-III

Course Code: M(ME) 301

Total Contact Hours: 44

Credits: 3

Prerequisite: Any introductory course on Calculus and Combinatorics.

Course Objective: The purpose of this course is to provide fundamental concepts of Fourier Series & Fourier Transform, Calculus of Complex Variables, Probability Distribution, Correlation & Regression, Ordinary Differential Equation, Partial Differential Equations.

Course Outcome: On successful completion of the learning sessions of the course, the learner will be able to

M(ME)301.1: Recall the distinctive characteristics of mathematical approaches like Fourier Series & Fourier Transform, Calculus of Complex Variables, Probability Distribution, Correlation & Regression, Ordinary Differential Equation, Partial Differential Equations.

M(ME)301.2: Understand the theoretical workings of mathematical approaches like Fourier Series & Fourier Transform, Calculus of Complex Variables, Probability Distribution, Correlation & Regression, Ordinary Differential Equations, and Partial Differential Equations to evaluate the various measures in related field.

M(ME)301.3: Apply various principles of Fourier Series & Fourier Transform, Calculus of Complex Variables, Probability Distribution, Correlation & Regression, Ordinary Differential Equations, Partial Differential Equations to solve various problems.

Module No.	Syllabus	Contact Hrs / No. of weekly classes
I	**Fourier Series and Fourier Transform:** Sub-Topics: Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave. **Euler's Formulae for Fourier Series, F**ourier Series for functions of period **2π, Fourier Series for functions of period , Dirichlet's conditions, Sum of** Fourier series. Examples. Theorem for the convergence of Fourier Series (statement only). Fourier Series of a function with its periodic extension. Half Range Fourier Series: Construction of Half range Sine Series, **Construction of Half range Cosine Series. Parseval's identity (statement only).Examples**	**10L**
	Fourier Transform: Sub-Topics: Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier, Fourier Cosine & Sine Transforms of elementary functions. Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples.Fourier Transform of Derivatives.Examples.Convolution Theorem (statement only), Inverse of Fourier Transform, Examples.	

II	**Probability Distributions:** Definition of random variable.Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties (without proof).Examples. Definitions of Expectation & Variance, properties & examples. Some important discrete distributions: Binomial, Poisson. Continuous distributions: Normal. Determination of Mean, Variance and standard deviation of the distributions. Correlation &Regression analysis, Least Square method, Curve fitting.	**10L**
III	**Calculus of Complex Variable** Introduction to Functions of a Complex Variable, Concept of Limit, Continuity and Differentiability. Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be analytic. Harmonic function and Conjugate Harmonic function, related problems. Construction of Analytic functions: Milne Thomson method, related problems. **Complex Integration.** Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a **piecewise smooth curve. Examples.Cauchy's theorem (statement** only).Cauchy-**Goursat theorem (statement only).Examples.Cauchy's integral formula, Cauchy's integral formula** for the derivative of an **analytic function, Cauchy's integral formula for the successive derivatives of an analytic function.Examples.Taylor's series, Laurent's series.**	**12L**

	Examples. **Zeros and Singularities of an Analytic Function & Residue Theorem**. Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and non-isolated singularity, essential singularities. Poles: simple pole, pole of order m. Examples on determination of **singularities and their nature. Residue, Cauchy's** Residue theorem (statement only), problems on finding the residue of a given function, Introduction Conformal transformation, Bilinear transformation, simple problems.	
IV	**Basic concepts of** Partial **differential equation (PDE)**: Origin of PDE, its order and degree, concept of solution in PDE. Introduction to different methods of solution: Separation of variables, Laplace & Fourier transform methods. Topic: Solution of Initial Value & Boundary Value **PDE's by Separation** of variables, Laplace & Fourier transform methods. PDE I: One dimensional Wave equation.	**12L**

Recommended Books:

1.Rathor, Choudhari,:Descrete Structure And Graph Theory.

2. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics - Sultan Chand & Sons.

3.Lipschutz S: Theory and Problems of Probability (Schaum's Outline Series) - McGraw HillBook.Co.

4. Spiegel M R: Theory and Problems of Probability and Statistics (Schaum's Outline Series) - McGraw Hill Book Co.

5. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics - The World Press Pvt. Ltd.

6. Spiegel M R: Theory and Problems of Complex Variables (Schaum's Outline Series) - McGraw Hill Book Co.

7. Bronson R: Differential Equations (Schaum's Outline Series) - McGraw Hill Book Co.

8. Ross S L: Differential Equations - John Willey & Sons.

9. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.

10. West D.B.: Introduction to Graph Theory - Prentice Hall

11. Deo N: Graph Theory with Applications to Engineering and Computer Science - Prentice Hall.

12. Grewal B S: Higher Engineering Mathematics (thirtyfifthedn) - Khanna Pub.

13. Kreyzig E: Advanced Engineering Mathematics - John Wiley and Sons.

14. Jana- Undergradute Mathematics

15. Lakshminarayan- Engineering Math 1.2.3

16. Gupta- Mathematical Physics (Vikas)

17. Singh- Modern Algebra

18. Rao B: Differential Equations with Applications & Programs, Universities Press

19. Murray: Introductory Courses in Differential Equations, Universities Press

20. Delampady, M: Probability & Statistics, Universities Press

21. Prasad: Partial Differential Equations, New Age International

22. Chowdhury: Elements of Complex Analysis, New Age International

23. Bhat: Modern Probability Theory, New Age International

24. Dutta: A Textbook of Engineering Mathematics Vol.1 & 2, New Age International

25. Sarveswarao: Engineering Mathematics, Universities Press

26. Dhami: Differential Calculus, New Age International

CO-PO Mapping:

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
M(ME) 301.1	3	2	-	-	-	-	-	-	-	-	-	1
M(ME) 301.2	3	2	-	-	-	-	-	-	-	-	-	1
M(ME) 301.3	3	2	2	-	-	-	-	-	-	-	-	1
Avrg.	**3**	**2**	**0.66**									**1**

Course Name: Physics-II,

Course Code: PH (ME) 301

Prerequisite:

Course Objective: To understand and apply the knowledge of advance physics in analyzing and solving problems of Mechanical Engineering

Course Outcome: Upon successful completion of this course, the student will be able to:

CO1: ability to define, understand and explain

- insulating and magnetic materials
- operator formalism in Quantum Mechanics
- categories of storage devices
- various types of nanostructures and their applications
- ultrasonic sound and its industrial applications
- energy band theory
- impact of defects in crystal structure

CO2: ability to apply the knowledge of

- Magnetism and semiconductors in data storage
- Motion of charges under a field in CRT
- Band theory in explaining electron transport in solids
- Magnetostriction and piezoelectricity in ultrasonic sound generation and detection

CO3: Ability to analyze

- Role of degenerate states in predicting energy bands of semiconductos
- Which type of magnetic materials to be used for data storage purpose
- Role of quantum confinement in inducing novel feature of a nanomaterial
- Quantum size effects and size quanization in quantum dot nanostructure

Beyond the syllabus to meet to CO:

- ✓ Basics of probability interpretation
- ✓ Failures of band theorgy in organic semicoducts

Module No.	**Syllabus**	**Contact Hrs. / No. of Lectures**
Module 1:	Electric and Magnetic properties of materials (7L)	
	Module 1.01 : Insulating materials: Dielectric Material: Concept of Polarization, the relation between D, E and P, Polarizability, Electronic (derivation of polarizability), Ionic, Orientation & Space charge polarization (no derivation), internal field, Claussius Mossotti equation, ferroelctric and piezoelectrics (Qualitative study).	3L
	Module 1.02 : Magnetic materials and storage devices: Magnetic Field & Magnetization M, relation between B, H, M. Bohr magneton, susceptibility, Diamagnetism- & Paramagnetism - Curie law (qualitative discussion), Ferromagnetism– Curie Temperature, Weiss molecular field theory (qualitative) & Curie-Weiss law, concept of θ_p , Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.)	4L
Module 2	Ultrasound and infrasound	4L

	Ultrasound-Introduction, definition and properties –Production of ultrasonics by Piezo-electric crystal and magnetostriction method; Detection of ultrasonics; Engineering applications of Ultrasonics (Non-destructive testing, cavitations, measurement of gauge), Infrasound – Introduction and definition, production, application:	
Module 3	Quantum Mechanics-II (7L) Formulation of quantum mechanics and Basic postulates- superposition principle, orthogonality of wave function, expectation value; operator correspondence, Commutator. Measurements in Quantum Mechanics-Eigen value, Eigen function, Schrödinger's equation as energy eigen value equation. Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well; Discussion on degenerate levels), 1D finite barrier problem and concept of quantum tunnelling (solve only $E<V_0$)	3L 4L
Module 4:	Statistical Mechanics (4L) Concept of energy levels and energy states. Microstates, Macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)- physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero & non-zero temperature,	4L

Text Books

1.Insulating Materials:Principles, Materials,Applications, MargitPfundstein, Roland Gellert,MartinSpitzner&AlexanderRudolphi: BirkhauserVerlagAG; 1 edition (1 April 2008)

2. High Voltage and Electrical Insulation Engineering, RavindraArora, Wolfgang Mosch: Online ISBN: 9780470947906 DOI:10.1002/9780470947906, Series Editor(s): Mohamed E. El-Hawary

3. Physics of Oscillations and Waves, N.K. Bajaj ,Publisher: McGraw-Hill Education –Europe

4. Waves andoscillations, Dr.P.K Mittal&Prof Jai DEV ,AnandHarAnand publications

5. Fundamental of Statistical Mechanics: B Laud

6. Introduction to statistical mechanics : .Pathria

7. Fundamental of Statistical andThermal Physics: .F. Reif

8. lectricity andMagnetism (In SiUnits): BerkeleyPhysics Course - Vol.2,Edward M Purcell

9. Introduction to Electrodynamics-Griffiths David J.

10.The Feynman Lectureson Physics. 2 (2nd ed.)Feynman, Richard P, Addison-Wesley.

11.Etching of Crystals-Theory, Experiment andApplication, K Sangwal

12.Nanostructure andNanomaterials, B.K.Parthasarathy

13. Introduction toNanotechnology, B.K. Parthasarathy

14. Essentials of Nanotechnology,RishabhAnand

15. NanomaterialsHandbook(Advanced Materials andTechnologies)-YuryGogotsi(Editor)

16. Introduction to Quantum Mechanics-S. N. Ghoshal(Calcutta Book House)

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	1	-	-	-	-	-	-	-	-	-	-
Avrg.	2	0.3										

Course Name: Strength of Materials Lab,

Course Code: ME 391

Prerequisite: Theoretical knowledge of Strength of Materials, Basic Mechanics

Course Objective: The objective of this lab is to practically demonstrate the failure criteria of different mechanical elements or bodies.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Measure tensile and compressive strength of a specimen for applying in a practical design based project work.
2. Practically determine hardness, impact strength, fatigue strength to analyze the application of a specific material for a given design requirements for different loading conditions of structures or machines.
3. Observe bending in beams and calculate the bending stresses which further builds the foundation of using modern analysis softwares.
4. Judge the capacity of a material to withstand torsional stresses for a safe and sustainable design of machine elements.

Course Articulation Matrix:

CO Codes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME391.1	1	-	3	-	-	-	-	-	3	-	2	-
ME391.2	1	-	2	-	-	-	-	-	2	-	2	-
ME391.3	1	-	2	-	3	1	-	1	2	-	2	-
ME391.4	1	2	3	-	-	-	-	-	2	-	2	-
Avrg.	1	0.5	2.5		0.75	0.25		0.25	2.25		2	

Experiment No.	Description	Remarks
1	Tension Test of ductile materials: stress-strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation and percentage reduction in areas, Observation of fractured surfaces.	
2	Compression of a brittle material	
3	Bend and rebend test of flat test pieces,	

	determination of bending stresses	
4	Torsion Test of a sample specimen.	
5	Hardness Tests: Brinnel and Rockwell tests of sample specimen	
6	Impact tests: Charpy and Izod tests of sample specimen.	

Course Name: Machine Drawing – I,

Course Code: ME392

Prerequisite: Basic knowledge of Machine elements, engineering drawing/drafting

Course Objective: The objective of this lab is to practically demonstrate the failure criteria of different mechanical elements or bodies.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Draw the isometric view of a given three dimensional object/part.
2. Draw the orthogonal projection of a solid body and assemble drawing using part drawings.
3. Represent different kinds of materials and Mechanical components conventionally.
4. Understand the shape and structure of different types of screws, keys and Couplings.

Course Articulation Matrix:

CO Codes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ME392.1	1	-	3	-	-	-	-	-	3	-	2	-
ME392.2	1	-	2	-	-	-	-	-	2	-	2	-
ME392.3	1	-	2	-	3	1	-	1	2	-	2	-
ME392.4	1	2	3	-	-		-	-	2	-	2	-
Avrg.	**1**	**0.5**	**2.5**		**0.75**	**0.25**		**0.25**	**2.25**		**2**	

Experiment No.	Description	Remarks
1	Schematic product symbols for standard components in mechanical welding symbols and pipe joints	
2	Orthographic projections of machine elements different sectional views- full, auxiliary sections Isometric projection of components	

3	Assembly and detailed drawings of a mechanical assembly 1) Plummer block 2) Tool head of a shaping machine 3) Tailstock of a lathe 4) Welded pipe joints indicating work parts before welding	

Recommended Books:

1. Text Book on Engineering Drawing, Narayana/ Kannaia H, Scitech
2. Mechanical Engineering Drawing and Design, S. Pal and M. Bhattacharyya
3. Machine Drawing by N.D. Bhatt
4. Machine Drawing by P.S. Gill

Course Name: Physics-II Lab,

Course Code: PH (ME) 391

Prerequisite:

Course Objective:

Course Outcome: Upon successful completion of this course, the student will be able to:

CO1: ability to define, understand and explain ✓ Dipolar magnetic behavior ✓ Action of capacitors ✓ Fermi levels and band gap in a semiconductor ✓ Function of Light emitting diode ✓ Magnetic and semiconductor storage devices ✓ Motion of electron under cross fields
CO2: Ability to conduct experiments using ➢ Insulators, Semiconductors (extrinsic and intrinsic), Light emitting diodes ➢ Cathode ray oscilloscope ➢ Various types of magnetic materials
CO3: Function effectively as an individual, and as a member or leader in laboratory sessions
CO4: Ability to communicate effectively, write reports and make effective presentation using available technology ➢ on presentation of laboratory experiment reports ➢ on presentation of innovative experiments

Module 1: Electric and Magnetic properties of materials	1.	Study of dipolar magnetic field behavior.
	2.	Study of hysteresis curve of a ferromagnetic material using CRO.
	3.	Use of paramagnetic resonance and determination of Lande-g factor using ESR setup.
	4.	Measurement of Curie temperature of the given sample.

	5. Determination of dielectric constant of given sample (frequency dependent)/Measurement of losses in a dielectric using LCR circuits
Module 2: Ultrasound and infrasound	6. Determination of velocity of ultrasonic wave using piezoelectric crystal.
Module 3: Quantum Mechanics-II	7. Determination of Stefan's radiation constant. 8. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power. 9. Measurement of specific charge of electron using CRT.
Module 5: Solid state physics (8L)	10. Study of lattice dynamics. 11. Determination of band gap of a semiconductor. 12. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor
Probable experiments beyond the syllabus:	1. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method. 2. Determination of thermal conductivity of a good conductor by Searle's mothod. 3. Study of I-V characteristics of a LED. 4. Study of I-V characteristics of a LDR 5. Study of transducer property: Determination of the thermo-electric power at a certain temperature of the given thermocouple.

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	3	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	1	-	-	-
CO4	-	-	-	-	-	-	-	-	-	3	--	-
Avrg.	**0.5**			**0.75**					**0.25**	**0.75**		

Course Name: Technical Skill Development,

Course Code: MC 381

Prerequisite: Basic Communication skill

Course Objective: To grow a potential of industrial skill development for future career.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Nurture their subject knowledge and find their relevance to practical application
2. Involve in more laboratory works to explore new findings.
3. Indulge in small projects for the development of the society and environment.

Course Articulation Matrix:

CO Codes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	1	2	-	2	-	-	-
CO2	-	-	-	-	-	1	-	-	2	-	-	-
CO3	-	-	-	-	-	3	-	-	2	-	-	-
Avrg.	**0.66**					**1.6**	**0.66**		**2**			

SEMESTER - IV

Course Name: FLUID MACHINERY,

Course Code: ME 401

Prerequisite: Knowledge of Fluid Mechanics and basic applications.

Course Objective: To understand the working principle of various hydraulic machines and judge their performance.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Understand the mechanism of jet propulsion for a variety of conditions and analyze it's effects for practical applications.
2. Learn the design and working principle of hydraulic turbines and apply in a practical case study or project work on hydel plants.
3. Analyze the working of centrifugal and reciprocating pumps and calculate their performance parameters of practical interest in a plethora of applications.
4. Get the knowledge about the working principles of various modern hydraulic machines for varied industrial applications.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Impact of Jets and Jet Propulsions: Force exerted by a liquid jet on a stationary flat plate, force exerted by a liquid jet on a stationary curved vane, force exerted by a liquid jet on a hinged plate, force exerted by a liquid jet on moving flat plates, force exerted by a liquid jet on moving curved vane, jet propulsion.	4
2.	Hydraulic Turbines: Essential element of a hydroelectric power plant;	8

	head and efficiencies of hydraulic turbines; classifications of hydraulic turbines, Pelton turbine, reaction turbine, Francis turbine, Kaplan turbine; draft tube; cavitation in hydraulic machines; dimensional analysis and similarity laws for rotodynamic machines; specific speed of hydraulic turbines; unit quantities of hydraulic turbines; characteristic curves of hydraulic turbines; governing of turbines.	
3.	Centrifugal Pump: Components of a centrifugal pump, working principle, work done, different heads in a pumping system, different efficiencies, characteristics, minimum speed for starting a centrifugal pump, multistage centrifugal pumps, specific speed, model testing, cavitation, net positive suction head.	8
4.	Reciprocating Pump: Components of a reciprocating pump, working principle, types of reciprocating pumps, discharge and power requirement, slip and coefficient of discharge, variation of velocity and acceleration in the suction and delivery pipes due to acceleration of the piston, frictional head on suction and delivery pipes, indicator diagram, air vessels.	8
5.	Miscellaneous Hydraulic Machines: Hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic ram, hydraulic lift, hydraulic crane, hydraulic coupling, hydraulic torque converter, gear pump, lobe pump, vane pump, piston pump, hydraulic actuators, hydraulic valves.	8

Text Books:

1. A textbook on Fluid Mechanics and Hydraulic Machines – Sukumar Pati, TMH
2. Fluid Mechanics & Machinery – R.K.Bansal, Luxmi Publications.
3. Introduction to Fluid Mechanics & Fluid Machines– Som Biswas, Chakraborty, TMH.
4. Fluid Mechanics & Turbo Machines – M.M. Das, PHI, 2010.

Reference Books:

5. Fluid Mechanics & Machinery – C. Ratnam, A.V. Kothapalli, I.K. International Publishing House Ltd, 2010.
6. Fluid Mechanics & Machinery – C.S.P Ojha, R. Berndtsson, P.N. Chandramouli, OUP.
7. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
8. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME401.1	3	2	2	1	-	-	-	-	-	-	1	-	1	2	1
ME401.2	2	3	2	2	-	1	-	-	-	-	1	1	1	3	1
ME401.3	2	2	1	1	-	1	-	-	-	-	1	-	1	3	1
ME401.4	2	3	2	-	1	1	1	-	-	-	1	2	-	1	1
Avrg.	**2.25**	**2.5**	**1.75**	**1**	**0.25**	**0.75**	**0.25**				**1**	**0.75**	**0.75**	**2.25**	**1**

Course Name: PRIMARY MANUFACTURING PROCESSES,

Course Code: ME 402

Prerequisite: Knowledge of basic workshop practices, material science.

Course Objective: To impart detailed knowledge on various primary manufacturing processes like casting, forming welding and power metallurgy.

Course Outcomes

Upon completion of this course, students will be able to:

1. Know the basics of manufacturing processes and concerned behavior of material properties.
2. Learn details of casting process, design of gating system and solidification for different molding design.
3. To get knowledge about basic welding and forming techniques and modern improvements for sophisticated metal works.
4. Know the basics of powder metallurgy to develop knowledge on modern nano-manufacturing for applied project works.

Module No.	Syllabus	Contact Hrs.
1	Introduction: Manufacturing; Definitions and broad grouping.	1
2	Casting: Introduction, History, Definition, Major Classification, Casting Materials. Sand mould casting: Moulding sands: composition, properties	12

	& testing. Design of gating system: sprue, runner, ingate & riser, Estimation of powering time, Foundry equipments, Furnaces Melting, pouring and solidification Type of patterning, use of a core. Different type of sand mould casting: Floor mould casting, Centrifugal casting, Shell mould & CO2 casting ,Investment casting. Permanent mould casting: Die casting, types, methods, advantages & applications. Slush casting, principle & use. Casting defects, types, causes & remedy	
3	Forming Processes: Forging: Introduction, definition, classification, hot forging & cold forging, characteristics & applications. Forging material operations, equipments & tools: Smith forging, Drop forging, Pressing or press forging, Forging dies, materials & design. Rolling: Introduction, basic principles, hot rolling & cold rolling, characteristics & applications. Rolling processes & applications, operations, equipments & roll stands. Wire drawing & extrusion: Basic principles & requirements. Classification, methods & applications. Miscellaneous forming processes.	8
4	Welding: Introduction to metallic parts, Major classification of joining processes, welding, brazing and soldering Broad classification of welding processes, types and principles. Fusion welding: types, principles, equipments, characteristics & applications, Sources of heat-chemical action, Gas welding & thermit welding ,Sources of heat-electrical energy, Arc welding, Submerged arc welding, TIG & MIG; Plasma arc welding, Resistance welding; Spot & butt welding. Solid state welding: Principles, advantages & applications of Hot forge welding, Friction welding, Pressure & percussion welding. Precision welding processes: Ultrasonic welding, Laser beam welding, Electron beam welding. Welding defects, types, causes & remedy.	12

5	Press tool works: Basic principles, systems, operations & applications, Shearing, parting, blanking, piercing & notching, Cupping (drawing), Spinning & deep drawing Blanks & forces needed for shearing & drawing operations, Coining & embossing.	3
6.	Powder Metallurgy: Development of powder metallurgy-scope of powder metallurgy, characterization of metal powders, physical properties and chemical properties. Powder manufacture: Reduction, electrolysis, and atomization processes. Compaction and sintering: Die compaction and other consolidation techniques, sintering, sintering with liquid phase, applications, advantages and limitations.	3

Text Books:

1. Manufacturing technology, Foundry, Forming & Welding-P.N Rao.
2. Manufacturing Science-A Ghosh & A Mullick.
3. Manufacturing Engineering & Technology-S Kalpakjian; Pub:Addison Wesle
4. Principles of manufacturing materials & processes-James & Campbell

Reference Books:

5. Manufacturing engineering & technology-K Jain.
6. Processes & materials of manufacturing-R.A Lindberg.
7. Introduction to manufacturing technology-PP Date, Pub: Jaico.
8. Manufacturing processes-S.K Sharma & S Sharma, Pub: I.K International.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME402.1	3	-	2	1	-	1	-	-	-	-	-	-	1	1	1
ME402.2	3	3	3	2	-	1	-	-	-	1	-	-	2	2	2
ME402.3	3	2	3	2	-	2	-	-	-	1	-	1	3	2	2
ME402.4	3	2	3	3	-	2	-	-	2	1	2	1	2	1	3
Avrg.	**3**	**1.75**	**2.75**	**2**		**1.5**			**0.5**	**0.75**	**0.5**	**0.5**	**2**	**1.5**	**2**

Course Name: ENGINEERING MATERIALS,

Course Code: ME 403

Prerequisite: Basic Physics and Chemistry.

Course Objectives: To impart overall knowledge of material structure, properties and treatments used in industries to make them useful for engineering applications.

Course Outcomes:

Upon successful completion of the course the students will be able to:

1. Different properties and classifications of materials that determine their applicability and concept of atomic structure, crystal structure, various imperfections in solids and solidifications.
2. Identify Iron-carbon equilibrium phase diagram, isomorphous and eutectic phase diagrams and distinguish between steels, cast irons and various non-ferrous alloys and describe methods, purposes and control of various heat treatment processes.
3. Explain with the special characteristics and applications of various types of polymer, ceramic and Composites.
4. Illustrate brief idea about corrosion with their types and control procedures of changing different mechanical properties of metals.

Course content

Module No.	Syllabus	Contact Hrs.
1	1.1 Introduction: Material Science—its importance in engineering; Atomic bonding in solids—bonding forces and energies; ionic/covalent/metallic bonding.	7
2	1.2 Crystal Structure: Fundamental concepts; Space lattice; Unit cells; Seven crystal systems; Single crystal; Polycrystalline and Non-crystalline materials; Metallic crystal structures—FCC, BCC & HCP structures ,atomic packing factor calculation. 1.3 Imperfections in Metals: Point defects due to vacancy & impurities; alloys, solid solutions, Hume Rothery rules; Dislocations—linear defects, interfacial defects, grain boundaries. 1.4 Diffusion: Definition; Interstitial and Substitutional diffusion Mechanism; Fick's first law and Fick's second law.	

3	3.1 Phase Diagrams: Definition and basic concepts; solubility limit; Phase equilibria; Gibb's phase rule; one component phase diagram, binary phase diagram, interpretation of phase diagrams. 3.2 Iron-carbon System: Allotropy of iron; iron-iron carbide phase diagram, properties and uses of; plain carbon steel. 3.3 Solidification: Concept of homogeneous heterogeneous nucleation process and free energy calculation for homogeneous nucleation process.	5
4	Heat Treatment: Definition and purposes; structural change during heating and cooling, Austempering, Martempering; Heat treatment processes for steels—Hardening (Carburizing, nitriding, cyaniding, induction and flame hardening); Tempering; Normalizing; Annealing—full annealing, spheroidising annealing, stress–relieving, recrystallisation annealing; Preciptation or Age Hardening of non-ferrous alloys.	5
5	Classification of Metals and Alloys- compositions, general properties and uses: 5.1 Ferrous alloys: Classification –low carbon steels, medium carbon steels, high carbon steels; Stainless steels; alloy steels; tool and die steel; cast irons. 5.2 Non-ferrous alloys: Copper & Copper alloys; Aluminum alloys; Nickel alloys; Lead & Tin alloys.	4
6	6.1 Polymers & Elastomers: Definition; advantages and disadvantages; Polymer compounding, Processing- Extrusion, blow molding. 6.2 Ceramic Materials: What is ceramics; Radius ratio rules; common ceramic materials AX type, Diamond and graphite structures and their characteristics; Properties and applications; Processing of ceramic—sintering and vitrification process. 6.3 Composite materials: What is composites; Advantages and disadvantages of composites; Polymers matrix and their applications; Metal matrix and	6

	ceramic matrix composites and their applications. Processing of composites- autoclave process, compression and injection molding.	
7	An introduction to advanced materials— Smart materials; Nano-materials; Biomaterials and Semiconductor.	1
8	Corrosion and Degradation of Engineering Materials: Definition; Dry and wet corrosion; Introduction to uniform, pitting(P-B ratio), galvanic, intergranular corrosion, stress corrosion cracking and erosion; Corrosion control — material selection, environment control.	2
9	Materials Selection Methodology: Selection of material based on required properties, availability, cost of material, environmental issues and manufacturing process.	1

Text Books:

1. Materials Science and Engineering by W.D. Callister and adapted by R. Balasubramaniam, Willey India, 2010 Ed.

2. Materials Science and Engineering (In SI Unit) by William Smith, Javad Hashemi, Ravi Prakash, 4th Ed., The McGraw-Hill Companies.
3. Materials Science and Engineering by V.Raghavan, 5th Ed., Prentice Hall India.

Reference Books:

5. Materials Science by S.L.Kakani and Amit Kakani , New age International Publishers.

6. Materials & Processes in Manufacturing by E.P.Degarmo and adapted by Black & Kosher, 10th Ed., Wiley India.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME403.1	3	2	1	-	1	2	1	-	-	-	3	-	2	-	-
ME403.2	2	3	2	-	3	1	2	-	-	-	2	-	1	-	-
ME403.3	3	3	2	-	2	3	2	-	-	-	2	1	-	-	2
ME403.4	2	3	1	-	3	2	1	-	-	-	2	1	-	-	2
Avrg.	**2.5**	**2.75**	**1.5**		**2.25**	**2**	**1.5**				**2.25**	**0.5**	**0.75**		**1**

Name of the Course: Mechanisms

Course Code: ME 404

Prerequisite: Basic Physics.

Course Objectives: To develop the knowledge on theory of machines for Analysis and design of gears, cams, and linkages.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Identify the basic relations between distance, time, velocity, and acceleration and distinguish between kinematic and kinetic motion.
2. Design basic gear trains, cam systems and also create a schematic drawing of a real-world mechanism.
3. Determine the degrees-of-freedom (mobility) of a mechanism.
4. Use graphical and analytic methods to study the motion of a planar mechanism.

Course content

Module	Syllabus	
1	Basics of Mechanisms Definitions – Link, Kinematic pair, Kinematic chain, Mechanism, and Machine. Degree of Freedom – Mobility - Kutzbach criterion (Gruebler's equation) Grashoff's law-Kinematic Inversions of four-bar chain and slider crank chain , Mechanical Advantage-Transmission angle. Description of common Mechanisms - Offset slider mechanism as quick return mechanisms, Pantograph, Straight line generators (Peaucellier and Watt mechanisms), Steering gear for automobile, Hooke's joint, Toggle mechanism, Ratchets and escapements - Indexing Mechanisms	10L
2	Kinematic Analysis Analysis of simple mechanisms (Single slider crank mechanism and four bar mechanism) -Graphical Methods for displacement, velocity and acceleration; Shaping machine mechanism - Coincident points – Coriolis acceleration - Analytical method of analysis of slider crank mechanism and four bar mechanism. Approximate analytical expression for displacement, velocity and acceleration of piston of reciprocating engine mechanism	6L
3	Belt-drive Introduction; Law of belting, Length of flat belt for open and cross belt connections; Stepped pulley for open flat belt; Tension in flat belt and V-belts; Power transmitted in belt drive.	4L
4	Gears Classification of gears – Gear tooth terminology - Fundamental Law of toothed gearing and involute gearing – Length of path of contact and contact ratio- Interference	6L

and under cutting. Gear trains – Simple, compound and Epicyclic gear trains - Differentials.

5	Kinematics of Cams Classification of Cams and followers; Radial Cam, Analysis of knife-edge, roller and flat face follower motion – constant velocity, simple harmonic, constant acceleration & deceleration; Offset follower.	5L
6	Kinematic Synthesis: Introduction to problems of function generation, path generation and rigid body guidance; Type, Number and Dimensional Synthesis; Two and three position synthesis of four bar mechanism and slider –crank mechanism : Graphical – pole, Relative pole and Inversion method; Analytical solution - Freudenstein's Method	5L

Text Books:

1. Elements of Mechanism – Daughty and James, McGraw Hill
2. Theory of Machines – S S Rattan, Tata McGraw Hill
3. Theory of Mechanisms & Machines – A.Ghosh & A.K.Mallik, AEWP

Reference Books:

4. Design of Machinery – R.L.Norton, Tata McGraw Hill
5. Mechanism & Machine Theory – Rao, R.V. Dukkipati, Wiley
6. Theory of Machines, V.P.Singh, Dhanpat Rai & Co

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME404.1	3	3	2	2	-	-	-	-	-	-	-	-	-	-	1
ME404.2	3	2	3	1	-	-	-	-	-	-	2	1	1	1	2
ME404.3	2	1	1	-	1	-	-	-	-	-	-	-	1	1	-
ME404.4	3	3	1	-	-	-	-	-	-	-	3	1	-	-	-
Avrg.	**2.75**	**2.25**	**1.75**	**0.75**	**0.25**						**1.25**	**0.5**	**0.5**	**0.5**	**0.75**

Course Name: Numerical Methods

Course Code: M(ME) 401

Prerequisite: Concept of Calculus and Algebra.

Course Objective: The purpose of this course is to provide basic understanding of the derivation and the use of the numerical methods along with the knowledge of finite precision arithmetic.

Course outcome: On successful completion of the learning sessions of the course, the learner will be able to:

M(ME)401.1: Recall the distinctive characteristics of various numerical techniques and the associated error measures.

M(ME)401.2: Understand the theoretical workings of various numerical techniques and to solve the engineering problems.

M(ME) 401.3: Apply the principles of various numerical techniques to solve various problems.

Course content

MODULE	Syllabus	Contact Hrs
Numerical method I	Approximation in numerical computation: Truncation and rounding errors, Propagation of errors. Propagation of errors, Fixed and floating-point arithmetic.	(2L)
	Interpolation: Newton forward/backward interpolation, Stirling & Bessel's Interpolation formula, Lagrange's Interpolation, Divided difference and Newton's divided difference Interpolation.	(7L)
	Numericalintegration:NewtonCotesformulba, Trapezoidal rule, Simpson's 1/3 rule, Weddle's Rule, Romberg Integration, Expression for corresponding error terms.	(5L)
	Numerical solution of a system of linear equations: Gauss elimination method,Tridiagonalmatrix algorithm, LU Factorization method, Gauss-Seidel iterative method, Successive over Relaxation (SOR) method.	(6L)
Numerical method	Solution ofpolynomialandtranscendental	(5L)

II	equations: Bisection method, Regula-Falsi, Secant Method, Newton-Raphson method.	
	Numericalsolutionofordinarydifferential equation:Taylor series method,Euler's method, Euler's	(6L)

Text Books:

1. Shishir Gupta &S.Dey, Numerical Methods, Mc. Grawhill Education Pvt. Ltd.

2. C.Xavier: C Language and Numerical Methods, New age International Publisher.
3. Dutta& Jana: Introductory Numerical Analysis. PHI Learning
4. J.B.Scarborough: Numerical Mathematical Analysis.Oxford and IBH Publishing

Reference Books:

5. Jain, Iyengar ,& Jain: Numerical Methods (Problems and Solution).New age International Publisher.
6. Prasun Nayek: Numerical Analysis, Asian Books.

Course Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
M(ME) 401.1	3	2	-	-	-	-	-	-	-	-	-	1
M(ME) 401.2	3	2	-	-	-	-	-	-	-	-	-	1
M(ME) 401.3	3	2	2	-	-	-	-	-	-	-	-	1
Avrg.	**3**	**2**	**0.66**									**1**

Course Name: FLUID MECHANICS & HYDRAULIC MACHINES LAB,

Course Code: ME491

Prerequisite: Knowledge of hydraulic machines

Course Objective: To expose students for operating hydraulic machines by themselves and measure their performance.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Measure the coefficient of discharge for several flow measuring devices to explore the reasons of differences in theoretical calculation and practical measurements.

2. Run variety of hydraulic turbine and carry out their performance study useful hydel power plants.

3. Run pumps and understand their behavior under given constraints.

4. Calculate frictional forces applicable in a flow channel to determine major and minor losses.

Course content

Experiment No.	Description	Remarks
1	To determine co-efficient of discharge of V-notch.	
2	To determine co-efficient of discharge of rectangular notch.	
3	To determine co-efficient of discharge of venturimeter.	
4	To determine co-efficient of discharge of orificemeter.	
5	Experimental verification of Bernoulli's theorem.	
6	To determine co-efficient of friction of fluid flowing through pipes.	
7	Reynold's experiment: Determination of Reynold's number for laminar and turbulent flow through pipes	
8	To determine efficiency of Francis turbine	
9	To determine efficiency of Pelton turbine	
10	To determine efficiency of centrifugal pump	

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME491.1			1						2	1				1	
ME491.2			3				1		2	1	1		2	1	1
ME491.3			1			1			2	1	1		2		
ME491.4			1	1					2	1	1			1	
Avrg.			**1.25**	**0.25**		**0.25**	**0.25**		**2**	**1**	**0.75**		**1**	**0.75**	**0.25**

Course Name: MATERIAL TESTING LAB,

Course Code: ME 492

Prerequisite: Knowledge of Material Science, Basic Sciences.

Course Objective: To test several properties of material like ductility, surface roughness, malleability, hardenability etc.

Course Outcome: Upon the completion of the course the student would be able to

1. Determine toughness value of industrial specimens.
2. Carry out various type of heat treatments of a given specimen to change associated mechanical properties and grain size
3. Find out surface or subsurface defects relevant to almost all manufacturing industries.
4. Measure the mechanical properties like drawability, endurance limit of a steel specimen necessary for material selection in design and development.

Course content

Experiment No.	Description	Remarks
1	To determine the percentage of clay content in dry sand	
2	To determine the grain fineness number of dry and clay free sand.	
3	To determine the moisture content quickly is fresh sand and mounding sand.	
4	To determination the compressive strength, splitting strength and shearing strength of green sand by Pendulum Type Universal Strength Machine	
5	To determine the permeability number of Green sand, Core sand and Raw sand.	
6	Mould preparation and casting of metals after preparation of suitable moulds.	
7	Study on the properties of post casting, fettling, cleaning, deburring and polishing operations.	
8	Practicing smithy or forging of carbon steels and testing for its property changes.	
9	Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW and SMAW and Testing for Joint defects.	

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME492.1			2		1				2	1	1				1
ME492.2			2	1	3				3	1	2	1	3		2
ME492.3			2	1	3				1	1	1	1			3
ME492.4			3	1	2	1	1		2	1	2	2			2
Avrg.			**2.25**	**0.75**	**2.25**	**0.25**	**0.25**		**2**	**1**	**1.5**	**1**	**0.75**		**2**

Course Name: MACHINE DRAWING – II,

Course Code: ME481

Prerequisite: Engineering Drawing.

Course Objective: To develop the capability of modeling important machine components using CAD.

Course Outcomes: After successful completion of the course, the student would be able to

1. Independently run Computer Aided Drafting software like AutoCAD.
2. Model basic two dimensional objects, modify and dimension them to form more complex machine parts of engineering importance.
3. Understand geometric construction and Solid Modeling concepts and techniques for both on paper and software.
4. Model three dimensional views of important machine parts and explore the plotting techniques for standard presentation.

Course content

Assignment No.	Description	Remarks
1	Assembly and detailed drawings of a mechanical assembly: A simple gear box	
2	Assembly and detailed drawings of a Flange Coupling	
3	Welded bracket joined by stud bolt on to a structure	
4	Practicing AutoCAD or similar graphics software	
5	Making orthographic projections of different components	

	using AutoCAD	
6	Making isometric projections of different components using AutoCAD	

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME481.1			1		3					1			2		
ME481.2			2		3					1	1		2		1
ME481.3			2		3					1	2		3		2
ME481.4			2		2					1	2		3		2
Avrg.			**1.75**		**2.75**					**1**	**1.25**		**2.5**		**1.25**

Course Name: Numerical Methods Lab

M(ME) 491:

Prerequisite: Any introductory course on C/ Mat lab.

Course Objective: The purpose of this course is to provide basic programming skills for solving the problems in numerical methods.

Course outcome: On successful completion of the learning sessions of the course, the learner will be able to:

M(ME) 491.1: Apply the programming skills to solve the problems using multiple numerical approaches.

M(ME) 491.2: Analyze if the results are reasonable, and then interpret and clearly communicate the results.

Course content

Serial No.	Assignments	Remarks
1	Assignments on Newton forward /backward, Lagrange's interpolation, Sterling & Bessel's Interpolation formula, Newton's divided difference Interpolation.	
2	Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule and Romberg Integration.	
3	Assignments on numerical solution of a system of linear equations using Gauss elimination, Tridiagonal matrix algorithm, Gauss-	

	Seidel iterations. Successive over Relaxation (SOR) method, LU Factorization method.	
4	Assignments on numerical solution of Algebraic Equation by Bisection method, Regula-Falsi method, Secant Method, Newton-Raphson method	
5	Assignments on ordinary differential equation: Euler's method, Euler's modified method, Runge-Kutta methods, Taylor series method and Predictor-Corrector method	
6	Assignments on numerical solution of partial differential equation: Finite Difference method, Crank–Nicolson method.	
7	Implementation of numerical methods on computer through C/C++ and commercial Software Packages: Matlab / Scilab / Labview / Mathematica/NAG (Numerical Algorithms Group/Python.	

CO-PO Mapping:

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
M(ME) 491.1	2	1	-	-	3	-	-	-	-	-	-	1
M(ME) 491.2	2	1	-	-	3	-	-	-	-	-	-	1
Avrg.	**2**	**1**			**3**							**1**

Subject Name: Technical Report Writing and Language Practice Lab (TRLP)

Subject Code: HU 481/HU381

Prerequisite: Basic Communication Skills.

Course Objectives: To impart skill-based lessons in a manner conducive to developing communicative and socio-linguistic competence in the learners.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Get skill-based lessons in a manner conducive to developing communicative and socio-linguistic competence in the learners.

2. Build General awareness building, through guided practice, of the taxonomy of listening and speaking skills and sub-skills.

3. Build Knowledge of the skills required for professional and public speaking so as to inculcate discourse competence in the learners.

4. Reinforce grammar skills and practice writing skills through the production of common industry and workplace documents.

4. Become familiar with basic sources and methods of research and documentation on topics in technology, including on-line research. They will be able to synthesize and integrate material from primary and secondary sources with their own ideas in research papers.

Course content

Course Articulation Matrix:

CO Codes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										3		
CO2										3		
CO3							1					
CO4						2						
CO5												1
Avrg.						**0.5**	**0.25**			**1.5**		**0.25**

Semester – V

Course Name: Heat Transfer,

Course Code: ME 501

Prerequisite: Basic Physics, Fluid mechanics

Course Objectives:

To Study the basic principles of heat transfers like conduction, convection and radiation for analyzing all heat exchanging devices used in industries.

Course Outcomes

Upon successful completion of this course, the student will be able to:

1. Understand the basic laws & constraints of heat transfer to analyze problems involving steady state or transient heat conduction in simple geometries.
2. Explore the analytical solutions of free and forced convection problems to apply in modern research sectors of heat and mass transfer.
3. Calculate radiation heat transfer between black body and gray body surfaces and obtain numerical solutions of combined mode heat transfer problems in practice.
4. Analyze the effectiveness of several type of heat exchanger and develop skills for industrial design solutions of complex problems.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Introduction to modes of Heat Transfer, Basic equations.	2
2.	Conduction: Fourier's law for isotropic materials. Thermal conductivity: 1-D and 3-D heat conduction equations, Boundary conditions. Solution of steady 1-D conduction problem with & without heat generation. Analogy with electrical circuits. Critical thickness of insulation.	4
3.	Fins, Rectangular and Pin fins, Fin effectiveness and Fin efficiency.	4
4.	Introduction to transient heat conduction, Lumped parameter approach, Time constant, Biot number: 1-D transient heat conduction solution without heat generation.	4
5.	Convective heat transfer, Newton's law of cooling and significance of heat transfer coefficients. Momentum and energy equation in 2-D.	3
6.	Non – dimensional quantities in heat transfer, Analysis for a flow over a flat plate, order of magnitude analysis.	3
7.	Boundary layer concepts, 1-D solution for Coutte flow and Poiseullie flow. Concept of developing and developed flow. Velocity and thermal boundary layer.	5
8.	Natural convection over a vertical plate. Concept and correlation.	3

9.	Radiation: Physical mechanism of thermal radiation, laws of radiation, Definition of black body, emissive power, intensity of radiation, emissivity, reflectivity, transmittivity, irradiation, radiosity.	3
10.	Radiation exchange between black bodies, concept of Gray- Diffuse Isotropic (GDI) surface. Radiation exchange between GDI surfaces by radiation network and radiosity matrix method. Radiation shielding.	4
11.	Heat exchangers: types of heat exchangers, parallel and counter flow types, Introduction to LMTD. Correction factors, fouling factor. E- NTU method for heat exchangers.	4
12.	Mass Transfer: Introduction, Modes of Mass Transfer, Fick's Law.	1
	Total	40 L

Text Books:

1. Yunus A. Cengel, Heat and Mass Transfer, The McGraw-Hill Companies.
2. Incropera, DeWitt, Bergmam, & Lavine, Fundamentals of Heat and Mass Transfer, Wiley India Edn.
3. P.K. Nag, Heat & Mass Transfer, TMH.

Reference Books:

1. J P Holman & Souvik Bhattacharyya, Heat Transfer, TMH.
2. S.K. Som, Introduction to Heat Transfer, PHI.
3. Kreith, Principles of Heat Transfer, Cengage learning.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME401.1	3	3	1	3		1	1				2	1	3	1	1
ME401.2	3	3	2	3		1	1				1	2	3	1	2
ME401.3	2	2	1	2		1	1				1	1	2	3	1
ME401.4	3	2	2	3		2	2				2	2	2	3	2
Avrg.	**2.75**	**2.5**	**1.5**	**2.75**		**1.25**	**1.25**				**1.5**	**1.5**	**2.5**	**2**	**1.5**

Course Name: DESIGN OF MACHINE ELEMENTS-I,

Course Code: ME 502

Prerequisite: Strength of Materials.

COURSE OBJECTIVES: To teach analytical methods of applying the concepts of stress analysis, theories of failure and material science to design, analyze or select commonly used machine components.

Course Outcomes: Upon successful completion of the course student will be able to:

1. Apply three different theories to the design of shafts subject to combined static and dynamic loads.
2. Identify, formulate and solve engineering problems by analyzing the design of spur gears with respect to tooth bending strength and surface strength specifications

3. Analyze and design hydrodynamic bearings using design charts and custom software and compute equivalent radial loads for rolling contact bearings to select appropriate bearings for the application.
4. To work in teams to analyze and design various types of brakes and clutches and present their designs orally and in writing.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials and manufacturing processes; codes and standards;	5
2.	Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability : buckling analysis – Johnson and Euler columns.	6
3.	Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.	6
4.	Design of (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types ofloading.	6
5.	Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies.	6
6.	Design of : (i)Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii)Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; (iii)Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, pulley. (iv)Chain drives – roller chains, polygonal effect, power rating, sprocket	10

	wheel, silent chain.	
7.	Design of: (i)Transmission screw, Screw jack, (ii)Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series; (iii)Multi-leaf springs : load-stress and load-deflection equations, Nipping	9

Text Books:

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley and Mischke, Mechanical Engineering Design, TMH.
3. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.

Reference Books:

1. P.C. Gope, Fundamentals of Machine Design, PHI.
2. M.F. Spotts, Design of Machine Elements, Prentice Hall.
3. P. Kannaiah, Machine Design, Scitech Publications.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME502.1	2	2	2	2		3	1	1			1	1	2		3
ME502.2	3	3	3	2		3	1	1			1	1	3	2	2
ME502.3	3	1	3			1		1			2	1	3	2	2
ME502.4	2	1	1			1		1		1	2	1	2	2	2
Avrg.	**2.5**	**1.75**	**2.25**	**1**		**2**	**0.5**	**1**		**0.25**	**1.5**	**1**	**2.5**	**1.5**	**2.25**

Course Name: DYNAMICS OF MACHINES

Course Code: ME503

Course Objectives: To study the dynamic behavior of a machine like vibration, balancing, governing etc.

Course Outcomes: Upon successful completion of the course student will be able to:

1. Analyze forced and free vibration in mechanical systems and use mathematical models to calculate dynamic forces involved in such systems.
2. Conduct static or dynamic balancing rotating and reciprocating equipments useful in all type of industries.
3. Analyze the design of governors and flywheels for establishing mechanical control over rotating mechanical linkages.
4. Propose the method of retaining the stability of Automobiles, Aeroplanes and ships using the understanding of **Course Articulation Matrix:**

Module No.	Syllabus	Contact Hrs.

1.A	Vibration: Definition & types of vibration; Differential equations of vibratory motions (longitudinal & torsional); Natural frequency of free longitudinal vibration-Equilibrium method, Energy method (Rayleigh's maximum energy principle); Effect of inertia in longitudinal vibration; Natural frequency of free transverse vibration of a beam due to point loads - Rayleigh's method.	6
1.B	Whirling of shaft, synchronous whirling; critical speed - Dunkerley's method.	2
2.	Free damped vibration; Damping factor; Logarithmic decrement.	2
3	Forced vibration, concept of under damped, critically damped and over damped system; Dynamic magnifier (magnification factor); Vibration isolation and transmissibility.	4
4.	Inertia force and inertia torque in reciprocating engine; Equivalent dynamical system; correction couple (torque); Turning moment diagram and flywheel design.	6
5.	Balancing: Static balancing; Dynamic balancing of rotating masses - graphical and analytical methods; Balancing of inline single cylinder and four cylinder engine; Balancing of symmetric two cylinder V-engine; Swaying couple; Hammer blow.	9
6.	Governors: Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors; Controlling force diagram and stability criteria analysis; coefficient of insensitiveness.	5
7.	Gyroscope: Gyroscopic couple and precessional motion; Effect of gyroscopic couple on aeroplane and ship; Stability of two wheel and four wheel vehicles taking turn.	2

Text Books:

1. W.T. Thomson, Theory of vibration with Applications, McGraw Hill.
2. Uicker, Pennock&Shigley, Theory of Machines and Mechanisms, OUP.
3. A. Ghosh & A.K. Mallik, Theory of Mechanisms and Machines, Affiliated East-West Publication.

Reference Books:

4. Rao &Dukkipati, Mechanism and Machine Theory, New Age Int. Pub.
5. J.S. Rao, The Theory of Machines Through Solved Problems, New Age Int. Pub.
6. S.S. Rattan, Theory of Machines, Tata McGraw Hill.

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME503.1	3	3	1	2							1		2	1	
ME503.2	3	2	1	2		2					1	1		2	
ME503.3	3	3	2	2							1				2
ME503.4	1	2	2	2	1	2					2			2	3

Avrg.	**2.5**	**2.5**	**1.5**	**2**	**0.25**	**1**					**1.25**	**0.25**	**0.5**	**1.25**	**1.25**

Course Name: Metrology and Measurement

Course Code: ME504

Course Objectives: To develop the knowledge of basic Measuring devices used in industries and research.

Course Outcome: Upon successful completion of this course Students will be able to

1. Get detailed knowledge about length and angle measuring and apply for checking the quality of manufactured products.
2. Explore the working principle of several instruments for displacement, temperature, pressure, load and force measurement useful in variety of industries
3. Get knowledge of limit, fit & tolerance and calibrate some unknown parameter of engineering interest.
4. Check the surface texture, flatness and roughness of a given specimen which is important in all kind of manufacturing.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Definition and importance of Metrology & Measurement; Methods of measurements – direct, indirect, comparison, substitution, transposition, deflection and null measurement; Errors in measurement – absolute, relative, parallax, alignment, loading, dynamic and calibration error; Units of measurements – SI base and derived units, SI prefixes of units.	3
2.A	Linear Metrology: Vernier scale; construction and use of Vernier calliper, Vernier height and depth gauge, micrometer; slip gauge.	3
2.B	Angular Metrology: Constructional features and use of protractor, Vernier bevel protractor, angle gauges, sine bar and slip gauges.	2
2.C	Measurements of : (i) Level using spirit-level; (ii) Flatness using straight edge, interferrometry (Newton's rings) and surface plate; Parallelism, cylindricity and concentricity using dial indicator.	3
3.	Interchangeability of components; concept of limits, tolerances and fits; Hole basis and shaft basis system of fits; Go and No Go limit gauges; plug, ring, snap, thread, radius and filler gauges.	5
4.	Definition, use and essential features of Comparators; working principle and application of some commonly used comparators.	4
5.	Measuring Instruments: Functional elements of an instrument – sensing, conversion & manipulation, data transmission and presentation element; Characteristics – sensitivity, precision and accuracy, repeatability, reproducibility, linearity, threshold, calibration, response, dynamic or measurement error; Transducers – definition, primary and secondary, active and passive.	5
6.	Definition of surface : Primary Texture, secondary texture and form error, lay, sampling length; Numerical evaluation of surface roughness: peak-to-valley	4

	height (Rmax), centre line average (CLA, Ra), Ten point average method (R_z) , E method & M method of surface roughness measurement,average depth (Rm), smoothness value (G); Principle of operation of a Talysurf.	
7.	Principle of operation of a few measuring instruments: displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter.	7

Text Books:

1. E.O. Doebelin and D.N. Manik, Measurement Systems– Application and Design, TMH
2. R. Rajendra, Principles of Engineering Metrology, Jaico Pub. House.
3. Beckwith, Lienhard and Marangoni, Mechanical Measurements, Pearson.

Reference Books:

1. Bewoor and Kulkarni, Metrology & Measurement, TMH.
2. R.K. Jain, Metrology, Khanna Publication, New Delhi.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME504.1	2		1										1		
ME504.2	3		2		1								2		
ME504.3	3		1										2		
ME504.4	2			2	2							1	1		1
Avrg.	**2.5**		**1**	**0.5**	**0.75**							**0.25**	**1.5**		**0.25**

Professional Elective-I

Course Name: REFRIGERATION & AIR CONDITIONING

Course Code: ME505A

Prerequisite: Applied Thermodynamics

Course Objective: To study and analyze various refrigeration systems along with Air Conditioning principle and design.

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

1. Explain different types of Refrigeration cycles and its applications in multi compressor and multi evaporator systems.
2. Propose the selection and design of different components of Refrigeration systems
3. Get thorough knowledge of psychometric processes and air conditioning systems.
4. Design the air-conditioning system for a given conditions including refrigerating equipments as well as ducting systems.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Concepts of Refrigeration and Air-conditioning. Unit of refrigeration, Refrigerants– Desirable Properties, Nomenclature	2
2.	Simple Vapour Compression Refrigeration System (Simple VCRS): Vapour compression cycle on ph and T-s diagrams. Cycles with subcooling and superheating, their effects; Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS; dry compression, wet compression of refrigerant; actual Vapour Compression Cycle.	5
3.	Air Refrigeration System (ARS): Bell-Coleman refrigerator. COP determination, actual air refrigeration cycle.	3
4.	Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithium bromide - water System; Aqua-ammonia systems.	4
5.	Equipment and Control: Major Refrigeration Equipment - Compressors: Types; reciprocating, rotary & centrifugal, volumetric efficiency, Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	5
6.	Ventilation – Definition & Requirement, Natural & Mechanical Ventilation, Ventilation Load Calculation.	3
7.	Basic definitions and principles related to Psychometry ; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor.	5
8.	Sensible Heat Factors. Heat Load estimation: Simple cases of Cooling and Dehumidification.	4
9.	Duct Sizing & Design.	2
10.	Air-conditioning equipment: Air handling units, Cooling Towers.	3

<u>Recommended Books:</u>

1. Stocker & Jones, Refrigeration and Air Conditioning, McGraw Hill.
2. C.P. Arora, Refrigeration and Air Conditioning.
3. P.L. Ballaney, Refrigeration and Air Conditioning.

<u>Reference Books:</u>

4. R.C.Arora, Refrigeration and Air Conditioning, TMH.
5. Arora and Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME505A.1	3	3	2	1		1	1				1				1
ME505A.2	2		2			1	3	1			2	1	2		1
ME505A.3	2	2	2								1		2		2
ME505A.4	3	1	3	1		1	2				2	2	3		3
Avrg.	**2.5**	**1.5**	**2.25**	**0.5**		**0.75**	**1.5**	**0.25**			**1.5**	**0.75**	**1.75**		**1.75**

Course Name: MECHATRONICS

Course Code: ME505B

Prerequisite: Fluid Mechanics, Basic Electronics

Course Objectives: To study various type of mechanical actuators and their control system applicable in industrial instrumentation.

Course Outcomes

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

1. Describe Mechatronics systems and overview of actuators.
2. Differentiate between various sensors, transducers, actuators and their applications.
3. Understand the basic concept of microprocessor.
4. Relate various signal conditioning units, amplifiers, logic gates and their role in Programmable logic controllers.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Introduction to Mechatronics: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering.	**3**
2.	Review of fundamentals of electronics, Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays.	**6**
3.	Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.	**3**
4.	Drives: Stepper motors, servo drives , Ball screws	**3**
5.	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them.Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.	**5**
6.	Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly	**3**

	and mnemonic programming on 8085 microprocessor.	
7.	Use of On-Off, PI and PID controllers to control different drives,	**2**
8.	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotary motion and its Laplace Transform.	**4**
9.	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	**4**
10.	Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNCmachine, AGV, etc.	**3**

Text Books:

1. N.P. Mahalik, Mechatronics, Tata McGraw Hill Publication
2. W. Bolton, Mechatronics, Pearson Education
3. A. Smaili and F. Arnold, Mechatronics, Oxford University Press, Indian Edition
4. M.D. Singh and J.G. Joshi, Mechatronics, Prentice Hall of India Pvt. Ltd.
5. K.K. AppuuKuttan, Mechatronics, Oxford University Press, New Delhi

Reference Books:

1. HMT Ltd., Mechatronics, Tata McGraw Hill Publication
2. F.H. Raven, Automatic Control Engineering, McGraw Hill International.
3. K. Ogata, Modern Control Engineering, Prentice Hall.
4. B.C. Kuo, Automatic Control Systems, Prentice Hall.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME505B.1	2				1							1			
ME505B.2	3	1	2		2		1				1	1	2		1
ME505B.3	2		1		2							1			1
ME505B.4	3	2	2		3		1				3	1	3		2
Avrg.	**2.5**	**0.75**	**1.25**		**2**		**0.5**				**1**	**1**	**1.25**		**1**

Course Name: APPLIED FLUID MECHANICS

Course Code: ME505C

Prerequisite: Basic fluid Mechanics

Course Objectives: Understand and analyze fluid behavior through various conduits and machineries.

Course Outcomes

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

1. Understand the detail of potential flows and explore basic design concept of nozzles to use in practical projects.
2. Analyze forces over an aerofoil section having huge practical application in Aviation industries.
3. Know the operating principles and constructional details of hydro turbine, compressors, fans and blowers etc.
4. Relate the knowledge gathered towards designing, testing, and installation of modern hydraulic systems.

Course content

Module No.	Syllabus	Contact Hrs.
1.	Specific energy, Hydraulic Jump	3
2.	Review of Compressible Flow, Design of convergent-divergent nozzle.	6
3.	Ideal Fluid Flow: rotation of a fluid particle, vorticity, rotational and irrotational motion; velocity potential function, circulation, stream function, flownet; governing equation for two dimensional irrotational motion, simple two dimensional irrotational flows like uniform flow, plane source, plane sink etc; superimposition of simple irrotational flows, combination of a source and a sink. Lift on aerofoil section or aircraft wings.	5
4.	Analysis of flow through propellers and windmills – slip stream theory, actuated disc theory; jet propulsion devices – analysis of thrust and other performance parameters.	5
5.	Similarity and model study in turbomachines: dimensional analysis of incompressible flow turbomachines, flow coefficient, head coefficient and power coefficient; non-dimensional plot of performance curves; specific speed; Cordier diagram; specific speed as a design parameter of imcompressible flow turbomachines; unit quantities for hydroturbines.	4
6.	Mechanical, hydraulic and volumetric loss in a turbo-pump; different types of losses in a hydroturbineinstallation; different efficiencies in turbomachines.	3
7.	Interaction of a turbomachine with the pipeline system; system head curve and point of operation, surging, series and parallel operation of pumps and fans.	4
8.	Testing of hydroturbines, different performance characteristics of hydroturbines like operating characteristics, main characteristics, Muschel curves; speed governing of hydroturbines – different methods.	4
9.	Torque converter and fluid coupling – function and performance.	2

Text Books:

1. N.P. Mahalik, Mechatronics, Tata McGraw Hill Publication
2. W. Bolton, Mechatronics, Pearson Education
3. A. Smaili and F. Arnold, Mechatronics, Oxford University Press, Indian Edition
4. M.D. Singh and J.G. Joshi, Mechatronics, Prentice Hall of India Pvt. Ltd.

Reference Books:

1. K.K. AppuuKuttan, Mechatronics, Oxford University Press, New Delhi
2. HMT Ltd., Mechatronics, Tata McGraw Hill Publication
3. F.H. Raven, Automatic Control Engineering, McGraw Hill International.
4. K. Ogata, Modern Control Engineering, Prentice Hall.
5. B.C. Kuo, Automatic Control Systems, Prentice Hall.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME505C.1	3	3	2	2					3				2		1
ME505C.2	3	2	2	3		1			3		2	1	1	1	2
ME505C.3	2	2	2	1		2			2		2	2	1	2	
ME505C.4	1	1	3	3		2	1	1	3	1	3	3	3	3	2
Avrg.	**2.25**	**2**	**2.25**	**2.25**		**1.25**	**0.25**	**0.25**	**2.75**	**0.25**	**1.75**	**1.5**	**1.75**	**1.5**	**1.25**

Course Name: Heat Transfer Lab

Course Code: ME 591

Prerequisite: Basic Physics, Fluid mechanics, Heat Transfer Theory

Course Objective: Practically measure the heat transfer through different kind of mediums.

Course Outcomes: Upon successful completion student will be able to:

1. Conduct investigation of problems involving steady state heat conduction in simple geometries.
2. Develop experimental solutions for problems involving free and forced convection
3. Differentiate radiation capabilities of black and grey surfaces by practical observation.
4. Analyze performance of basic types of heat exchangers and solve complex industrial problems.

Course content

1) Determination of dryness fraction of steam by combined separating and throttling calorimeter.

2) Study and performance test of a single acting reciprocating air compressor.

3) Determination of thermal conductivity of a metal rod.

4) Determination of thermal conductivity of an insulating powder/or an insulating plate.

5) Determination of ‘h’ for forced convection over a pin fin.

6) Verification of emissivity of a plate.

7) Study of a shell and tube heat exchanger and determination of LMTD.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME591.1		1	2	3					2		1		1	1	2
ME591.2		1	2	2					2		1	1	2	1	2
ME591.3		1	1	1					2		1		1	1	3
ME591.4		2	2	1					3		2	1	2	1	3
Avrg.		**1.25**	**1.75**	**1.75**					**2.25**		**1.25**	**0.5**	**1.5**	**1**	**2.5**

Course Name: Dynamics of Machines Lab

Course Code: ME 592

Prerequisite: Theory of machines, Dynamics of Machine Theory

Course Objective: To practically observe the dynamic behaviors of machines and their components.

Course Outcomes: Upon successful completion of this course students will be able to

1. Experimentally verify knowledge of several types of vibrating systems by using vibration measuring instruments, vibration of continuous systems, random vibrations.
2. Observe the method of balancing of rigid rotors, reciprocating machines, flywheels, planar linkages and instrumentation.
3. Visualize the working principle of gyroscope and governors to apply in future projects
4. Get practical knowledge on Cam dynamics used in various industrial applications.

Course content

1. Studying and designing different mechanisms for performing specific tasks in a machine tool, and for common engineering applications.
2. Studying vibratory systems of single and more than one degree of freedom in linear and rotory systems;
3. Static and dynamic balancing of rotating masses;
4. Balancing of reciprocating masses;
5. Experiments on working of governor, operation and analysis.
6. Experiments on working of gyroscope, operation and analysis.
7. Designing cam,
8. Studying operation of cams and its analysis.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME592.1		3	2	1					3	1	1	1	3		3
ME592.2		1	2						3	1				2	
ME592.3		1	3		1				2	1	1		1		2
ME592.4		1	3						2	1		1			2
Avrg.		**1.5**	**2.5**	**0.25**	**0.25**				**2.5**	**1**	**0.5**	**0.5**	**1**	**0.5**	**1.75**

Course Name: Metrology & Measurement Lab;

Course Code: ME 593

Prerequisite: Metrology & Measurement Theory, Physics.

Course Objective: Hands on experience with various measuring instruments to utilize in industries.

Course Outcomes: Upon successful completion of this course Students are able to

1. Use different length measuring instruments like vernier calipers, micrometer
2. Use different angle measuring instrument like universal bevel protractor, sine bar

3. Calibrate some unknown quantity or parameter of engineering interest.
4. Check the surface quality of a given specimen which is important in all kind of manufacturing.

Course content

1. Taking measurements using following instruments :
(i) Vernier height & depth gauge, (ii) Dial micrometer, (iii) Thread gauge, (iv) Radius gauge, (v) Filler gauge, (vi) Slip gauge.
2. Measurement of angle of a component using :
(i) Vernier bevel protractor, (ii) angle gauges , (iii) Sine-bar and slip gauges.
3. Checking / measuring parallelism, cylindricity and concentricity of components using dial indicator.
4. Measurement of surface finish by a Talysurf instrument.
5. Use of profile projector for checking profile of saw teeth, thread etc.
6. Calibration of cantilever type dynamometer.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME593.1		2	2						3	1					
ME593.2		1	2						3	1					
ME593.3		1	3						2	1	2	2			1
ME593.4		1	3						2	1	2	1			3
Avrg.		**1.25**	**2.5**						**2.5**	**1**	**1**	**0.75**			**1**

Course Name: Seminar

Course Code: ME 582

Prerequisite: Basic Communication Skill

Course Objective: Train students to deliver an effective technical presentation in front of any audience.

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

1. Get thorough knowledge of preparing a technical seminar presentation in power point format which will be visually effective to reach any number of audiences.
2. Understand the methods of delivering and explaining technical terms through effective diagram selection and white board.
3. Review all core areas of Mechanical Engineering for variety of topics and enhance presentation skill by increasing level of detailing.
4. Achieve confidence to face any audience and communicate with them in a disciplined manner, face and reply queries patiently.

Course content

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME591.1									1	3	1			1	2
ME591.2									1	3	1	1		1	2
ME591.3	1								1	3	1			1	3
ME591.4									2	3	2	1		1	3
Avrg.	**0.25**								**1.25**	**3**	**1.25**	**0.5**		**1**	**2.5**

Course Name: Refrigeration & Air Conditioning Lab;

Course Code: ME 594A

Prerequisite: Applied Thermodynamics, Refrigeration &Air Conditioning Theory

Course Objective:

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

1. Visualize a domestic refrigerator and identify its important components.
2. Experimentally determine the performance parameters of a vapor compression based refrigeration system
3. Observe the components of a basic air conditioning setup and operate it to determine its performance index.
4. Recognize the components of a thermoelectric refrigeration setup and measure its coefficient of performance useful in future project applications.

Course content

1. Study of a Domestic Refrigerator.
2. Study of a room (window type) Air Conditioner.
3. Study of a room (split type) Air Conditioner.
4. Determination of C.O.P of a vapour compression refrigeration system.
5. Experiment in an Air Conditioning Test Unit; Determination of bypass factor and plotting of the cooling – dehumidification process on a psychometric chart.
6. Performance test of thermoelectric refrigeration system.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME505A.1	1	-	-	-	-	1	-	-	3	2					1
ME505A.2	1	-	2	-	-	-	-	-	3	2	1		1	1	1
ME505A.3	1	-	2	-	1	1	1	-	3	2	1	1	1	1	2
ME505A.4	1	-	1	-	1	-	2	-	2	2			2		3
Avrg.	**1**		**1.25**		**0.5**	**0.5**	**0.75**		**2.75**	**2**	**0.5**	**0.25**	**1**	**0.5**	**1.75**

Course Name: Mechatronics lab

Course Code: ME594B

Prerequisite: Fluid Mechanics, Basic Electronics, Mechatronics Theory

Course Objective: To expose students to modern control system using mechanical actuators.

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

1. Describe Mechatronics systems and overview of control systems & actuators.
2. Differentiate between various sensors, transducers and actuators and their applications.
3. To understand the basic concept of microprocessor.
4. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.

Course content:

1. Open loop position control;
2. Closed loop position control using positional and velocity feedback;
3. Use of analog and digital servosystems,
4. Use of PID control;
5. Experiments on pneumatic drives and actuators;
6. Experiments on hydraulic drives and actuators;
7. Use of logic gates
8. Programming on a 8085 Microprocessor training kit.
9. Programming on a PLC for simple control operations.

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME505B.1	1		2		1				2	1	2				
ME505B.2	1		2		1					1	3	1	2		1
ME505B.3	1		2		2					1	2				
ME505B.4	2		3		1					1	3		1		1
Avrg.	**1.25**		**2.25**		**1.25**				**0.5**	**1**	**2.5**	**0.25**	**0.75**		**0.5**

Course Name: Applied Fluid Mechanics Lab;

Course Code: ME 594C

Prerequisite: Basic Fluid Mechanics, Applied Fluid Mechanics theory

Course Objective: To expose students towards advanced experiments related to research.

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

1. Determine the nature of turbulence inside a flow at various flow velocities.
2. Validate the Stokes law by experimental investigation.
3. Deal with hydro turbines and analyze their characteristics.
4. Investigate the flow patterns of an open channel flow and understand its practical implications.

Course content

1. Study of cavitation characteristics of centrifugal pump.
2. Study of the characteristics of submerged jet.
3. Study of characteristics of hydraulic jump.
4. Study of cavitation phenomenon.
5. Verification of Stokes law.
6. Determination of loss through pipes and fittings.
7. Performance test of pumps in series & parallel

Course Articulation Matrix:

CO Codes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
ME505C.1			2						3	1					1
ME505C.2			2						3	1					2
ME505C.3		2	2						2	1	1		1	1	
ME505C.4		1	3	1					3	1			1	2	2
Avrg.		**0.75**	**2.25**	**0.25**					**2.75**	**1**	**0.25**		**0.5**	**0.75**	**1.25**

Department of Mechanical Engineering

COMMON AUTONOMOUS SYLLABUS for '2016-20' AND '2017-21' BATCH

(As Approved by BOARD OF STUDIES on 26/10/18)

3rd Year: 6th SEMESTER

Subject Type	Subject Code	Subject Name	Contact Hours/Week				Total Credits
			L	T	P	Total	
THEORY:							
PC	ME 601	MACHINING PRINCIPLES & MACHINE TOOLS	3	0	0	3	3
PC	ME 602	DESIGN OF MACHINE ELEMENTS-II	3	0	0	3	3
PC	ME 603	IC ENGINE & GAS TURBINE	3	0	0	3	3
PE-II	ME 604A	ROBOTICS: MECHANICS AND CONTROL	3	0	0	3	3
	ME 604B	COMPOSITE MATERIALS					
	ME 604C	FLUID POWER CONTROL					
OE-I	ME605A	RENEWABLE ENERGY SYSTEMS	3	0	0	3	3
	ME 605B	COMPUTATIONAL FLUID DYNAMICS					
	ME 605C	GAS DYNAMICS AND JET PROPULSION					
PRACTICAL:							
PC	ME 691	MACHINING & MACHINE TOOLS LAB	0	0	3	3	2
PC	ME 692	DESIGN PRACTICE LAB	0	0	2	2	1
PC	ME 693	I C ENGINE LAB	0	0	3	3	2
PE LAB-II	ME 694 A	ROBOTICS LAB	0	0	3	3	2
	ME 694 B	COMPOSITE MATERIALS LAB					
	ME 694 C	FLUID POWER CONTROL LAB					
SESSIONAL:							
PROJECT	ME 681	MINI PROJECT-II	0	0	3	3	2
MANDATORY	MC 682	GROUP DISCUSSION	0	0	2	2	0
		TOTAL: Eleven	15	0	16	31	24

Note: Vacational Training to be conducted up to 6th semester and to be evaluated in 7th semester.

4th Year: 7th SEMESTER

Subject Type	Subject Code	Subject Name	Contact Hours/Week				Total Credits
			L	T	P	Total	
THEORY:							
PC	ME 701	POWER PLANT ENGINEERING	3	0	0	3	3
PC	ME 702	ADVANCED MANUFACTURING TECHNOLOGY	3	0	0	3	3

PE-III	ME 703 A	ADVANCED WELDING TECHNOLOGY	3	0	0	3	3
	ME 703 B	BIOMECHANICS & BIOMATERIALS					
	ME 703 C	FINITE ELEMENT METHOD					
PE-IV	ME 704 A	TRIBOLOGY	3	0	0	3	3
	ME 704 B	OPERATIONS RESEARCH					
	ME 704 C	MATERIALS HANDLING					
OE-II	ME 705 A	ENERGY CONSERVATION & MANAGEMENT	3	0	0	3	3
	ME 705 B	QUALITY & RELIABILITY ENGINEERING					
	ME 705 C	HYDRO, WIND AND WAVE POWER					
PRACTICAL:							
PC	ME 791	ADVANCED MANUFACTURING LAB	0	0	2	2	1
PE-III lab	ME 793 A	ADVANCED WELDING LAB	0	0	2	2	1
	ME 793 B	BIOMECHANICS & BIOMATERIALS LAB					
	ME 793 C	FINITE ELEMENT METHOD LAB					
SESSIONAL:							
PW	ME 781	PROJECT- I	0	0	6	6	3
PW	ME 782	DESIGN OF MECHANICAL SYSTEM	0	0	3	3	2
PW	ME 783	VIVA-VOCE ON VACATIONAL TRAINING	0	0	0	0	2
		TOTAL: Ten	15	0	13	28	24

4th Year: 8th SEMESTER

Subject Type	Subject Code	Subject Name	Contact Hours/Week				Total Credits
			L	T	P	Total	
THEORY:							
HU	HU(ME)801	PRINCIPLES OF MANAGEMENT	2	0	0	2	2
PE-V	ME 802A	AUTOMOBILE ENGINEERING	3	0	0	3	3
	ME 802B	CAD/CAM					
	ME 802C	AUTOMATION & CONTROL					
OE-III	ME 803A	TURBO MACHINERY	2	0	0	2	2
	ME 803B	MAINTENANCE ENGINEERING					
	ME 803C	NUMERICAL HEAT TRANSFER					
OE-IV	ME 804A	SAFETY & OCCUPATIONAL HEALTH	2	0	0	2	2
	ME 804B	NUCLEAR POWER GENERATION AND SUPPLY					
	ME 804C	FRACTURE MECHANICS					
SESSIONAL:							
PW	ME 881	PROJECT II	0	0	12	12	6
PW	ME 882	GRAND VIVA	0	0	0	0	2
		TOTAL: SIX	9	0	12	21	17

SYLLABUS OF 6TH SEMESTER COURSES

THEORY COURSES

Paper Name: Machining Principles and Machine Tools

Paper Code: ME601 Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Machining: Basic principle, definition and requirements. Geometry of cutting tools: Geometry of single point turning tools in ASA, ORS and NRS systems, Conversion of tool angles by graphical and vector methods, Geometry of drills and milling cutters.	5
2.	Mechanism of machining: Chip formation mechanism, yielding and brittle fracture, chip reduction coefficient, cutting ratio, shear angle and cutting strain. Built-up edge formation and effects, orthogonal and oblique cutting. Chip formation in drilling and milling. Mechanics of machining: Determination of cutting forces, cutting force, Merchant's circle diagram, analytical methods, Dynamometers, working principles of strain gauge type and piezoelectric crystals type dynamometers.	8
3.	Cutting temperature: Heat generators and cutting zone temperature, Effect of machining parameters. Determination of cutting temperature by analytical and experimental methods, application of cutting fluids. Cutting tools- failure mechanisms, geometry and assessment of tool wear. Tool life assessment, Taylor's tool life equation. Cutting tool materials, essential properties, applications of HSS, carbide, ceramic, diamond and CBN tools.	5
4.	Broaching and grinding: Modes of chip formation, Grinding forces, surface roughness and wheel life. Machinability and grindability, improvement and evaluation of optimum cutting velocity and tool life.	3
5.	Machine tools – Introduction, Purpose of use, definition and general features of machine tools. Generatrix and Directrix and tool–work motions in different operations of conventional machine tools. Major components and their functions in lathes; shaping, planing and slotting machines; drilling machines and milling machines. Machining operations and application of the common machine tools and their way of specification.	7
6	Kinematic structure of machine tools: Kinematic structure of centre lathe, shaping, planing and slotting machine. Kinematic structure of drilling (column/radial) and milling machines, capstan lathe, turret lathes. Automation: Purposes, degree, type and economy of machine tool automation; broad classification of machine tools.	6

Recommended Books:

1. A. B. Chattopadhyay, Machining and Machine Tools, Wiley India (P) Ltd., New Delhi.
2. G. Kuppuswamy, Principles of Metal Cutting, University Press, Hyderabad.
3. Stephenson & Agapion, Metal Cutting Theory and Practice, Taylor and Francis, NY.
4. M.C. Shaw, Metal Cutting Principles and Practices, Oxford University Press.
5. G.C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Cantral Book Agency (P) Ltd., Kolkata.
6. Acharkan, Machine Tool Design, Vol. I, II, III and IV, Mir Publication, Moscow.

Paper Name: DESIGN OF MACHINE ELEMENTS - II

Paper Code: ME602 Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Clutches: Function, types; Friction clutches – torque capacity based on uniform pressure and uniform wear theory for disc and cone clutch; Centrifugal clutch; Friction materials; Considerations for heat dissipation.	4
2.	Brakes: Function, types; pivoted block brake (single and double block brakes), internal expanding shoe brake, self energizing and self locking; Pivoted block brake; Band brake-simple and differential; Energy equation for braking time calculation; Magnetic and hydraulic thruster operated fail-safe brakes; Brake lining materials; Thermal considerations during braking.	4
3.	Gears: Design objectives, types, terminologies, conjugate action and involute tooth profile, tooth systems, standard modules; Gear materials. Spur Gear : Strength design, static and dynamic considerations in strength design, Lewis formula, Lewis form factor, beam strength, Buckingham equation for dynamic tooth load; Endurance strength and wear strength; Designing a pinion based on above considerations; Helical Gear: Helix angle, minimum face width, virtual number of teeth; Strength design, Buckingham formulae for checking dynamic load and wear load.	6
4.	Bevel Gear: Terminologies, formative number of teeth; Lewis equation, dynamic load, endurance strength and wear strength checking. Worm- worm wheel: Terminologies and their inter-relation; Preferred combination of various parameters; Efficiency; Materials.	4
5.	Pressure vessels– thin cylinder, thick cylinder, Lame's equation, Clavarino's equation, Birnie's equation, Autofrettage– compound cylinders, End Covers, Opening in pressure vessel – area compensation method, Fired and unfired vessels – category, Industrial Code.	6
6.	Sliding contact bearings: Bearing types and materials; Stribeck Curve, Petroff equation,	6

	Hydrodynamic lubrication theory - pressure development; Tower experiment, Reynolds equation, Finite bearings – Raimondi Boyd charts, Design factors/variables, Heat Generation & dissipation; Hydrostatic bearing; Plummer block.	
7.	Rolling contact bearings: Bearing types, nature of load; Static and dynamic load capacity, Stribeck equation, Load - Life relation; Bearing selection from manufacturers' catalogues; Methods of lubrication; Bearing mounting on journal and bearing block.	4

Recommended Books

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley and Mischke, Mechanical Engineering Design, TMH.
3. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.
4. Hamrock, Schmid, Jacobson, Fundamentals of Machine Elements, Mcgraw Hill.
5. Burr and Cheatham, Mechanical Analysis and Design, Prentice Hall.
6. P. Kannaiah, Machine Design, Scitech Publications.
7. P.C. Gope, Fundamentals of Machine Design, PHI.

Paper Name: I.C Engines And Gas Turbine

Paper Code: ME 603 Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Classification and working of basic engine types: 2-stroke & 4-stroke Engines, SI & CI Engines, Engine Nomenclature, Review of Air Standard Cycles	3
2.	Fuel-Air cycles: Assumptions, Effect of specific heat & Dissociation, Performance analysis of fuel air cycle. Actual cycles: Assumptions, Heat Loss, Time loss and Blowdown loss, Optimum spark advance	5
3.	Fuels: classification and desirable characteristics, HCV and LCV, Rating of fuels, Alternative fuels. Combustion of fuels in S.I and C.I engines, Parameters influencing combustion, Detonation and knocking in S.I. and C.I. engines and their preventions, Types of combustion chambers, Analysis of combustion product	6

4.	Fuel-Air mixing in SI Engines, Analysis of a simple carburetor, Disadvantages. Fuel injection systems: Working principle, Injection pumps and nozzles, electronic fuel injection system, Basic principles of MPFI	6
5.	Ignition systems: ignition timing and spark advance, firing order. Scavenging: ideal and actual, scavenging pumps, Supercharging and Turbo charging	4
6.	Introduction to Gas Turbine Cycles & Performance, Effect of Intercooling, Reheating and Regeneration, Applications of Gas Turbine	4
7.	Cooling and Lubrication: Properties of lubricating oil, Air and liquid cooling. Scavenging: ideal and actual, scavenging pumps, Supercharging and Turbo charging	3
8.	Performance and testing; Measurement of speed, torque, fuel consumption, IHP, BHP and FHP, SFC, thermal efficiency, Emission Control	3

Recommended Books:

1. V. Ganesan, Internal Combustion Engines, The McGraw-Hill Companies.

2. M.L. Mathur and R.P. Sharma, A course in Internal Combustion Engines, Dhanpat Rai & Sons.

3. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Private Ltd.

Professional Electives II

Sl. No.	Paper Code	Subject Name
1.	ME604 A	ROBOTICS: MECHANICS AND CONTROL
2.	ME 604 B	COMPOSITE MATERIALS
3.	ME 604 C	FLUID POWER CONTROL

Paper Name: Robotics: Mechanics And Control

Paper Code: ME 604A Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	**Introduction** 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;	4

	Robot specifications: payload, accuracy, repeatability resolution, maximum tip speed, reach stroke:	
2.	**Robot End Effector** End effector: definition, gripper, tools; Gripper : main parts, source of power; Types of grippers: mechanical grippers, vacuum cups, magnetic grippers, adhesive grippers, Hooks, scoops, ladles, universal gripper; Robot Tools: Spot welding gun, pneumatic impact wrench, pneumatic nut runner, inert gas welding torch, heating torch, grinder, spray painting gun.	4
3.	**Robot Actuators:** Definition; Characteristics: power to weight ratio, stiffness, compliance, reduction gears; Conventional actuators: hydraulic actuator, pneumatic actuator, electric motor, direct drive motor, stepper motor, servo motor; Special actuators: magnetostrictive, shape memory alloy, elastomer.	4
4.	**Robot Sensors:** Definition; of Sensor and transducer; Calibration; Basic categories of measuring devices: analog, discrete; Main types of sensors: position, velocity, acceleration, force and pressure, torque, slip and tactile, proximity. Definition of digital image, generation of digital image; Robot Vision System: definition, use, functions, components, classification; vision cameras; Techniques of image processing and analysis: Image data reduction, segmentation, feature extraction, object recognition; Application of robot vision system.	7
5.	**Robot Kinematics:** Definition of Robot kinematics, Tool frame and base frame. Word –coordinate system, Direct kinematics, Inverse kinematics, Describing position and orientation of an object in space, Homogenous transformation, Translational transformations, Rotational transformations, Denavit- Hartenberg representation.	5
6.	**Robot Programming** Definition of robot programming; Different methods of robot programming: teach-pendant programming, key board programming; Programming languages: VAL II, AML/2, ARM BASIC	4
7.	**Industrial Applications of Robots** Welding, Spray painting, Grinding; Material Transfer: machine loading and unloading, Processing operation; Assembly operation; Inspection. Special applications: underwater prospecting and repairs, Mining, Space Exploration, Surgery.	4

Recommended Books

1. Klafter, Richard D. Chmielewski, Thomas A. and Negin, Michael (2001) - Robotic Engineering: An Integrated Approach, Prentice-Hall of India Pvt. Limited.
2. Mikell P. Groover, Mitchell.Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill International Edition
3. S.R. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill Publication.
4. S.K. Saha, Introduction to Robotics, The McGraw-Hill Publication
5. Niku, Saeed B., Introduction to Robotics Analysis, Systems, Applications, Prentice Hall of India Private Limited, New Delhi
6. Koren, Yoram, Robotics for Engineers, McGraw-Hill Book Company, Singapore

Paper Name: Composite Materials

Paper Code: ME604B Contact Hours: 32L Credit: 3

Module	Syllabus	Contact Hours
1	**Introduction:** Definition of composite material, Classification based on matrix and topology,	3

	Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites	
2	**Performance of Structural and Nonstructural Composites:** Combination effects, Basic analytical concepts, Performance analysis by various models, Strengthening mechanisms, Stress distribution in fibre and the matrix, critical length of fibre for full strengthening, Composites in Electrical, Superconducting and Magnetic applications, Nano-composite devices	6
4	**Fabrication of Composites :** Fabrication of Metal Matrix Composites: Commonly used Matrices, , solidification processing of composites - XD process, Spray processes - Osprey Process, Rapid solidification processing, Dispersion Processes - Stir-casting & Compocasting, Screw extrusion, Liquid metal impregnation technique – Squeeze casting, Fabrication of Polymer Matrix Composites - Commonly used Matrices Basic Requirements in selection of Constituents, Moulding method, Low pressure closed moulding, pultrusion, Filament winding, Fabrication of ceramic matrix composites - Various techniques of vapor deposition, Liquid phase method and Hot pressing etc., Fabrication of nanocomposites	8
5	**Characterization Composites:** Control of particle/fibre and porosity content, particle/fibre distribution, Interfacial Reaction of matrix-reinforcing component, Coating of reinforcing component, Strength analysis	5
6	**Secondary Processing and Joining of Composite :** Forging and extrusion of composites – critical issues, dynamic recovery and dynamic recrystallisation, mechanical properties; Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplastic graphite composite, Weld bonding, Brazing of MMC.	6
7	**Industrial Application of Composite Materials :** Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components	4

References:

1. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.
2. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
3. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Kidlington, Oxford OX5lGB, UK.
4. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993) Chapman & Hall, London.
5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.

Paper Name: Fluid Power Control

Paper Code: ME604C Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1	Introduction to Fluid power Applications and advantages; Components of a hydraulic and pneumatic system. Desired properties of a hydraulic fluid; advantage of mineral oil over water; definition of terms like pressure, head, force, density, specific gravity, kinematic and absolute viscosity, compressibility and incompressibility, Pascal's law; analysis of simple hydraulic jack, Mechanical advantage; continuity equation; hydraulic power of a cylinder.	5
2.	Hydraulic Pumps: positive displacement pumps; constructional features, working principle and volumetric Capacity of external gear pump, vane pump, axial piston pump and radial piston pump.	6
3.	Hydraulic Actuators : (i) Constructional features of single acting and double acting hydraulic cylinders; mounting of cylinders, cushioning of cylinder; different application of cylinder through mechanical linkages; force, velocity and Power from a cylinder. (ii) Hydraulic motors; torque, power and flow rate in a hydraulic motor.	4
4.	Advantages & disadvantages of pneumatic system compared to hydraulic system; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator, lubricator and silencer; symbols of different pneumatic components; compressed air distribution system in a plant; drawing Pneumatic circuits for different operations.	5
5.	Hydraulic Valves : Direction control valves – operation and graphical symbol of 3 way and 4 way valves; different modes of activation of valves; Operation and symbols of check valves, pressure relief valve, pressure reducing valve, unloading valve and flow control valve.	4
6.	ANSI symbols for different hydraulic components. Analysis of hydraulic circuits : single acting cylinder control, double acting cylinder control, regenerative circuit, pump unloading circuit, double pump hydraulic system, cylinder synchronization circuit, speed control of a hydraulic motor, circuit to lift and hold heavy load, Automatic sequencing of two cylinders.	5
7.	Use of electrical devices for controlling fluid circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; concept of ladder diagram, study of circuits using electrical control devices	3

Open Electives I

SL. No	Paper Code	Subject Name
1.	ME605A	RENEWABLE ENERGY SYSTEMS
2.	ME 605B	COMPUTATIONAL FLUID DYNAMICS
3.	ME 605C	GAS DYNAMICS AND JET PROPULSION

Paper Name: Renewable Energy Systems

Paper Code: ME605A Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Principles of Renewable Energy: The history and future of energy scenario, Sustainable Development and role of renewable energy, Scientific Principles of renewable energy. Review of principles: thermodynamics, fluid dynamics and heat transfer	4
2.	Solar radiation: (i) Sun-Earth geometry (ii) Extraterrestrial Solar Radiation (iii) Measurement and estimation of solar radiation. Photovoltaic Generation: (i) Photon absorption at Silicon p-n junction (ii) Solar Cell (iii) Application and Systems.	6
3.	Solar Water Heating: (i) Flat Plate Collectors: Heat Transfer analysis, Testing (ii) Evacuated Tube Collectors. Applications: (i) Air heaters (ii) Water Desalination (iii) Space Cooling (iv) Solar Concentrators (v) Solar ponds.	5
4.	Wind Power: Wind Turbine types & Principles, Calculation of Power production from Wind mills, Betz Criteria	4
5.	Wave Power & tidal Power: Basic Concepts of Wave Power, Tidal Basins, Determination of energy conversion. Ocean Thermal Energy Conversion.	5
6.	Geothermal Energy: Location and Extraction, Petrothermal systems, Geothermal energy based vapor power cycles	4
7.	Biomass & Bio fuels: (i) Use of Biomass (ii) Classification & Use of Bio fuels. Energy Storage, Pumped Hydro Systems	4

Recommended Books:

1. Renewable Energy – G. Boyle, 2nd edition, OUP, 2010.
2. Renewable Energy Resources- Twidell, J & Weir, T, 2nd edition, Taylor & Francis, 2006.
3. Non Conventional Energy Resources- B.H. Khan, T M H, 2010.
4. Non Conventional Energy Sources- G.D. Rai, Khanna Publishers.

Course Name: COMPUTATIONAL FLUID DYNAMICS

Course Code: ME605B Contact Hours: 32L Credit: 3

Module	Syllabus	Contact Hours
1.	**Introduction:** Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description. Boundary and initial conditions; overview of numerical methods.	6
3.	**Finite Difference Techniqu**e: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion; treatment of boundary conditions; boundary layer treatment; accuracy of f.d. method.	4
4.	**Finite Volume Technique:** Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.	5
5.	**Finite Element Methods:** Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.	5
6.	**Methods of Solution:** Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.	6
7.	**Time integration Methods:** Single and multilevel methods; predictorcorrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems. Basics of numerical grid generation.	6

References:

1. S.V.Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.

2. H.K.Versteeg & W. Malalasekera,An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical. J. H. Ferziger and M.Peric, Computational Methods for Fluid Dynamics,Springer.

3. John C. Tannehill, Dale A.Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer

4. Taylor &Francis. John D.Anderson Jr, Computational Fluid Dynamics, McGraw Hill Book Company

Paper Name: GAS DYNAMICS AND JET PROPULSION

Paper Code: ME605C Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	COMPRESSIBLE FLOW - FUNDAMENTALS Energy and momentum equations for compressible fluid flows - various regions of flows -	5

	reference velocities - stagnation state - velocity of sound - critical states - Mach number – critical Mach number - types of waves - Mach cone - Mach angle - effect of Mach number on flow.	
2.	FLOW THROUGH VARIABLE AREA DUCTS Isentropic flow through variable area ducts- T-s and h-s diagrams for nozzle and diffuser flows - Area ratio as a function of Mach number - Mass flow rate through nozzles and diffusers - Effect of friction in flow through nozzles.	6
3.	FLOW THROUGH CONSTANT AREA DUCTS Flow in constant area ducts with friction (Fanno flow) – Fanno curves and Fanno flow equation - variation of flow properties - variation of Mach number with duct length. Isothermal flow with friction in constant area ducts. Flow in constant area ducts with heat transfer (Rayleigh flow) - Rayleigh line and Rayleigh flow equation - variation of flow properties - Maximum heat transfer.	6
4.	NORMAL AND OBLIQUE SHOCKS Governing equations - Variation of flow parameters like static pressure, static temperature , static density, stagnation pressure and entropy across the normal shock - Prandtl Meyer equation - impossibility of shock in subsonic flows - flow in convergent and divergent nozzle with shock - normal shock in Fanno and Rayleigh flows, flow with oblique shocks.	7
5.	PROPULSION Jet Propulsion: Aircraft propulsion - types of jet engines – energy flow through jet engines- performance of turbo jet engines - thrust - thrust power - propulsive and overall efficiencies – thrust augmentation in turbo jet engine - ram jet and pulse jet Engines. Space Propulsion: Types of rocket engines - Propellants - Ignition and combustion - Theory of rocket propulsion –Terminal and characteristic velocity - Applications.	8

Recommended Books

1. YAHYA. S.M. - "Fundamental of compressible flow"- New Age International (p) Ltd. - New Delhi 1996.
2. PATRICH.H. OOSTHVIZEN-WILLIAM E.CARSCALLEN- "Compressible fluid flow"- McGraw-Hill- 1997
3. COHEN. H. - ROGERS R.E.C AND SRAVANAMUTOO- "Gas turbine theory"- Addison Wesley Ltd. - 1987.
4. GANESAN. V. - "Gas Turbines"- Tata McGraw-Hill- New Delhi- 1999
5. RATHAKRISHNAN.E- "Gas Dynamics"- Prentice Hall of India- New Delhi- 2001
6. HILL.D and PETERSON .C, Mechanics & Thermodynamics of propulsion - Adisson Wesley Publishing Company, 1999.
7. G.P.Sutton- "Rocket Propulsion Elements "- John Wiley- 1986- New York.
8. ZUCROW N.J Principles of Jet Propulsion and Gas Turbines - John Wiley Newyork, 1970

Practical Courses

Machining & Machine Tools Lab - ME-691 **Contacts: 3P** **Credits: 2**
1. Measurement of cutting forces in straight turning at different feeds and velocities 2. Measurement of surface roughness in turning under different conditions 3. Study of chip formation and evaluation of chip reduction coefficient 4. Measurement of tool – wear and evaluation of tool life 5. Acceptance test of a machine tool. 6. Study of gear cutting in milling machine

Machine Design Practice - ME 692 Contacts: 3P Credits: 1
Drawing board exercises and Computer terminal exercises compatible to theory course on ME 502 and ME 602: Design of Machine Elements I & Design of Machine Elements II

1. At least **three assignments** on 2-D modelling of mechanical components using Drawing board exercises
2. At least **two assignments** on 2-D and 3-D modelling of mechanical components and systems using software packages like AUTOCAD, CATIA, PRO E or similar software
3. At least **one assignment** on design analysis of mechanical components using software packages like CATIA, PRO E or similar software.
4. At least **one assignment** on Design Practice using codes, e.g., Pressure vessel codes, Gear design codes etc.
5. At least **one assignment** on Selection of mechanical components from manufacturers' catalogue, e.g., chain drive, rolling element bearings etc.

I.C. Engines Lab - ME-693 Contacts: 3P Credits: 2
1) Study of cut models of Two stroke and four stroke Petrol and Diesel Engines.
2) Study of valve timing diagram of Petrol & Diesel Engine.
3) Determination of flash point and fire point of sample oil.
4) Determination of calorific value of a fuel by Bomb calorimeter.
5) Performance Test of a Diesel Engine using Mechanical and Electrical dynamometer.
6) Morse Test on multi cylinder petrol engine by electrical break dynamometer.

Professional Electives Lab II

SL. No.	Paper Code	Subject Name
1.	ME 694 A	ROBOTICS LAB
2.	ME 694 B	COMPOSITE MATERIALS LAB
3.	ME 694 C	FLUID POWER CONTROL LAB

ROBOTICS LAB - ME 694 A Contacts: 3P Credits: 2
1. Demonstration of ROBOT with 2 DOF, 3 DOF, 4 DOF
2. Study and selection of Gripper.
3. Programming exercise of robots for Pick and Place activity.
4. Case studies of applications in industry like Spray Painting or Welding
5. Exercise on Robotic Simulation software, using Fanuc Robo guide

COMPOSITE MATERIALS LAB - ME 694 B Contacts: 3P Credits: 2
1. Fabrication of any Metal Matrix Composite
2. Fabrication of any Polymer/ceramic Matrix Composite
3. Welding of two composite specimens

4. Determination of Mechanical properties of a composite specimen 5. Determination of Porosity of a composite specimen

FLUID POWER CONTROL LAB- ME 694 C Contacts: 3P Credits: 2
1. To demonstrate the motion of a single acting cylinder and double acting cylinder in pneumatic system. 2. To demonstrate the use of direction control valve with double acting cylinder in hydraulic system. 3. To demonstrate the use of pressure control valve in a circuit. 4. To perform AND & OR logic for forward stroke of a double acting cylinder using two manual control. 5. To control the speed of a double acting cylinder using metering in and metering out flow control valve 6. To operate two double acting cylinders (Sequence of operation: A+B+A-B-).

SESSIONAL

Mini Project-II - ME 681 - Contacts: 3P - Credits: 2

Students in small groups will perform either an Industrial case study, or Preparation of a feasibility report, or Experimental investigation, or Computational/ Theoretical work, or Design and development of equipment/system. An industrial case study/ project, if undertaken by the student, is to be supervised jointly by industry personnel and a teacher. The task is to complete over a period of two semesters, and the progress of the work will be evaluated through presentation of the same in front of a panel of examiners followed by a viva voce examination.

Group Discussion - MC 682 Contacts: 2P Credits: 0

Group of students will discuss on a given topic or debate demonstrating their communication and interpersonal skills.

SYLLABUS OF 7TH SEMESTER COURSES

Theory Courses

Paper Name: Power Plant Engineering

Paper Code: ME 701 Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Power plant process layout, Plant economics: load curve and various factors, cost of power generation.	4
2.	Boilers: Definition, classification, fire tube and water tube boilers, mountings and accessories. Introduction to boiling and circulation in boilers. Boilers accessories: Super heater, economizer and air-pre heater. Power station boilers - Benson, Lamont. Supercritical boiler. Combined Cycle power generation.	6
3.	Coal and combustion: Properties of coal, proximate and ultimate analysis, calculation of theoretical and actual air. Fuel bed firing, PF firing and Fluidized bed boilers. Losses in boilers, boilers efficiency, equivalent evaporation. Draft in boilers. Ash handling systems.	8
4.	Steam turbine- i) parts and classification, ii) nozzles types, flow through nozzles and nozzle efficiency. Impulse turbine - velocity diagram, work done and blade efficiency.	6
5.	Pressure compounding and velocity compounding of steam turbine. Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine. Governing in Steam turbine.	4
6.	Condensing Systems, Cooling Towers	2
7.	Introduction to Hydel, Nuclear and Renewable power plants.	4

Recommended Books:

1. P.K. Nag, "Power plant Engineering," Tata McGraw - Hill.

2. Arora and Domkundwar, "A course in Power plant Engineering" Dhanpat Rai & Sons.

3. M.M.EI- Wakil, "Power plant technology," Tata McGraw - Hill.

Paper Name: Advanced Manufacturing Technology

Paper Code: ME 702 Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction to Advanced Manufacturing Technology	1
2.	Manufacturing Systems and Automation : Job shop, Flowlines, Transfer lines, Project shop, Continuous processes, Cellular manufacturing system, Flexible Manufacturing System:	8

	Automation: (i) degree of automation and their justified application in different levels of production (ii) benefits and draw backs of employing automation (iii) examples of conventional non-automatic, semi-automatic and automatic machine tools (iv) extent of automation in transfer machines Integrated Manufacturing Production System: Steps involved in implementation, forming the linked-cell factory.	
3	Basic systems of NC and CNC machines: coordinate system, control – open loop and closed loop, dimensioning – absolute and incremental CNC machine tools ; structure and working principle machining centre (MC) – characteristics and applications. Control of tool – work travel, point – to – point and contouring, interpolation – linear and circular Part programming for NC, CNC and MC systems, Codes used, sequential steps, examples; part programming for machining in CNC lathes, drilling machines and milling, Computer aided part programming, advantages, programming languages, statements in APT, examples	7
4.	Non Traditional Manufacturing -Advantages, classification, characteristics Abrasive Jet Machining (AJM): principle, material removal rate Water Jet Machining, Applications, Advantages and limitations. Ultrasonic Machining (USM): Working principle, Influence of Process parameters, Applications. Plasma Arc Machining- principle, applications. Chemical Machining- Blanking, Design factors, advantages and disadvantages. Electro-Chemical Machining, Applications. Electrical Discharge Machining (EDM), Wire-cut EDM: working principle, Dielectric fluid, Advantages & Disadvantages. Electron Beam Machining Principle and Applications. Die sinking. Laser Beam Machining (LBM): Characteristics of Ruby laser, Carbon Dioxide laser, Welding Heat treating, cladding. Hybrid Machining	12
7.	Rapid Prototyping- Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slice the STL File, Layer by layer construction, Clean and finish. Principles, systems, relative advantages and applications of the common RP methods ; (i) stereo lithography (SLG) (ii) selective laser sintering (SLS) (iii) fused deposition modeling (FDM) (iv) laminated objects manufacturing (LOM) (v) 3-D Inkjet Printing	6

Recommended Books:

1. Fundamentals of Modern Manufacturing by Mikeel P. Grover– 3E Wiley
2. Automation, Production systems and CIM – M.P. Groover , Prentice Hall
3. Non conventional machining – P.K. Mishra, Narosa
4. Manufacturing science – Ghosh & Mullick, EWP
5. Rapid prototyping – A. Ghosh, EW Press
6. Non traditional Manufacturing Processes by Gary F. Benedict– Marcel Dekker
7. Micromaching of Engineering Material by Mc Geongh, J.A. – Marcel Dekker
8. Advanced Machining Process, Nontraditional and Hybrid Machining Processes by Hassan Abdel- Gawad El- Hofy – McGraw Hill, Mechanical Engineering Science

Professional Electives III

SL. No.	Paper Code	Subject Name
1	**ME 703 A**	**ADVANCED WELDING TECHNOLOGY**
2	**ME 703 B**	**BIOMECHANICS & BIOMATERIALS**
3	**ME 703 C**	**FINITE ELEMENT METHOD**

Paper Name: Advanced Welding Technology

Paper Code: ME 703A Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Review of welding processes, joint design.	3
2.	Process descriptions of and parametric influences on fusion welding; arc welding- SMAW, submerged arc welding, GMAW, GTAW and FCAW, solid state welding processes- pressure welding, friction welding, diffusion welding; resistance welding processes.	6
3.	Arc welding- different types of equipment, power sources, arc characteristics, electrode selection.	5
4.	Critical and precision welding processes like: PAW, LBW, EBW, USW, friction stir welding, under-water welding. Welding of plastics, ceramics and composites.	5
5.	Welding metallurgy, HAZ, effects of different process parameters on the characteristics of weldment. Welding fixtures, welding automation and robotic applications	5
6.	Weldability of plain carbon steels, stainless steel, cast iron, aluminium and its alloys.	4
7.	Welding defects- types, causes, inspection and remedial measures; testing of welded joints by visual inspection, dye-penetration (DP) test, ultrasonics and radiography. Safe Practices in Welding.	4

Recommended Books:

1. O.P. Khanna, A Text Book of Welding Technology, Dhanpat Rai & Sons.
2. R.S. Parmar, Welding Engineering and Technology, Khanna Publishers.
3. M. Bhattacharyya, Weldment Design, The Association of Engineers, India Publication, Kolkata.
4. J.C. Lippold and D.J. Kotecki, Welding Metallurgy and Weldability of Stainless Steels, Wiley-India (P) Ltd., New Delhi.
5. Udin, Funk and Wulf, Welding for Engineers, John Wiley and Sons.
6. J.L. Morris, Welding Process and Procedures.
7. S.V. Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd./ Advani-Oerlikon Ltd.

Paper Name: Biomechanics & Biomaterials

Paper Code: ME 703B Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1	**Musculoskeletal Anatomy**: Basic Statics and Joint Mechanics (elbow, shoulder,	4

	spine, hip, knee, ankle)	
2	**Basic Dynamics to Human Motion**: Review of linear and angular kinematics; Kinetic equations of motion; Work & energy methods; Momentum methods; Examples in biomechanics; Modern kinematic measurement techniques; Applications of human motion analysis Structure, Function, and Adaptation of Major Tissues and Organs	6
3	**Fundamental Strength of Materials in Biological Tissues**: Introduction to Viscoelasticity. **Fundamentals of biomaterials science**. Concept of biocompatibility. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Disinfection and sterilization of biomaterials.	6
4	**Physico-chemical properties of biomaterials**: mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermal), chemical and biological properties	6
5	**Elements in contact with the surface of a biomaterial**: blood composition, plasma proteins, cells, tissues. Phenomena at the biointerfaces. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body.	6
6	**Testing of biomaterials**: in vitro, in vivo preclinical and in vivo clinical tests. Technologies of biomaterials processing, as implants and medical devices; improvement of materials biocompatibility by plasma processing.	4

Recommended Books:

1. Fundamentals of Biomechanics: D V Knudson, Springer.
2. Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, by Ozkaya and Nordin, Springer.
3. Biomechanics: Mechanical Properties of Living Tissues, by Fung, Springer
4. Basic Biomechanics of the Musculoskeletal System, by Nordin & Frankel, Barnes & Noble.
5. Biomaterials Science, An Intoduction to Materials in medicine, Eds. B. D. Ratner and A. S. Hoffman, Academic Press, New York.

Paper Name: Finite Element Method

Paper Code: ME 703 C Contact Hours: 3L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Historical background, Relevance of FEM to design problems, Application to the continuum– Discretisation, Matrix approach, Matrix algebra– Gaussian elimination, Governing equations for continuum, Classical Techniques in FEM, Weighted residual method, Ritz method, Galerkin method	8
2.	One dimensional problems: Finite element modeling– Coordinates and shape functions, Potential energy approach– Element matrices and vectors, Assembly for global equations, Boundary conditions, Higher order elements- Shapes functions, Applications to axial loadings of rods– Extension to plane trusses, Bending of beams– Finite element formulation of stiffness matrix and load vectors, Assembly to Global equations, boundary conditions, Solutions and Post processing, Example Problems.	8
3.	Two dimensional problems– scalar variable problems: Finite element modeling– CST element, Element equations, Load vectors and boundary conditions, Assembly, Application to heat transfer, Examples	4

4.	Two dimensional problems– vector variable problems: Vector Variable problems, Elasticity equations– Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions Examples	8
5.	Isoparametric elements for two dimensional problems: Natural coordinates, Iso parametric elements, Four node quadrilateral element, Shape functions, Element stiffness matrix and force vector, Numerical integration, Stiffness integration, Displacement and Stress calculations, Examples.	6
6.	Computer implementation: Pre-processor, Processor, Post-processor. Discussion about finite element packages.	2

Recommended Books:

1. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, Prentice Hall-India, New Delhi.
2. T.R. Chandrupatla and A.D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India.
3. C.S. Krishnamoorthy, Finite Element Analysis, TMH.
4. K-J. Bathe, Finite Element Procedures, Prentice Hall.
5. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Elsevier.
6. J.N. Reddy, An Introduction to the Finite Element Method, McGraw-Hill.

Professional Electives IV

SL. No.	Paper Code	Subject Name
1	ME 704 A	TRIBOLOGY
2	ME 704 B	OPERATIONS RESEARCH
3	ME 704 C	MATERIALS HANDLING

Paper Name: TRIBOLOGY

Paper Code: ME 704A Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction: History, Industrial Importance. Engineering Surfaces: Properties and Measurement: Measurement Methods, Surface Profilometry, Statistical Description of Roughness.	4
2.	Surface Contact: Hertz contact theory, Greenwood-Williamson model, Elastic-plastic contact. Adhesion: Basic Models, Factors influencing Adhesion.	4
3.	Friction: Measurement Methods, Origin of Friction, Friction Theories – adhesion and ploughing, Mechanisms, Friction of Metals, Non-metallic Materials.	4
4.	Wear: Types: Adhesive, Abrasive, Corrosive, Fatigue, Minor Forms: Fretting, Erosion, Percussion, Delamination Theory, Wear Debris Analysis, Wear Testing Methods, Wear of Metals, Ceramics, Polymers.	6

5.	Surface Engineering: Surface Treatments: Microstructural and Thermochemical Treatments, Surface Coatings: Hard Facing, Vapour Deposition Processes: PVD, CVD, PECVD etc.	4
6.	Lubrication: Basic Equations for Fluid Film Lubrication. Hydrodynamic lubrication -Thrust and Journal bearings, Squeeze Film Bearings, Hydrostatic lubrication, Gas-Lubrication. Lubrication of rolling element bearings. Boundary lubrication – metal working lubrication, solid film lubrication. Hygiene of lubricants.	8
7.	Nanotribology: Measurement Tools: Surface Force Apparatus, Scanning Tunneling Microscope, Atomic / Friction Force Microscope.	2

Recommended Books:

1. P. Sahoo, Engineering Tribology, Prentice Hall-India, New Delhi, 2009.
2. B. Bhushan, Introduction to Tribology, Wiley, 2002.
3. G W Stachowiak and A W Batchelor, Engineering Tribology, Butterworth-Heinemann,2005.
4. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals of Tribology, Prentice Hall-India, 2005.
5. B C Majumdar, Introduction to Tribology of Bearings, S Chand & Co, 2012.

Paper Name: Operations Research

Paper Code: ME 704 B Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	**Introduction:** Brief history; different O.R. problems and techniques, Inventory control, Metaheuristics	2
2.	**Decision Theory:** Structure of the problem (decision table); Decision making under uncertainty with optimistic, pessimistic and average outcome criteria; Decision making under risk with expected value and expected loss criteria; Sequential decision using decision trees.	4
3.	**Linear Programming (LP);** Nature of LP problems through examples; Formulation of LP Problems; Graphical solutions of two decision variable problems; Properties of a solution to LP problems: convex solution space and extreme point solution; General form of LP model; Simplex method and its meaning; Steps of simplex method in tabular form; Solving LP problems by Simplex Method; Sensitivity analysis.	6
4.	**Transportation & Assignment Problems:** Nature of a transportation or distribution problem; Tabular representation of a transportation problem; North-West Corner initial solution; Stepping stone method; Concept of dummy source or destination; Vogel's approximation method. Nature of an Assignment problem; Tabular representation; Hungarian method for solving assignment problems.	5
5.	**Network Analysis:** Network models and terminologies like arcs, nodes, paths, tree, spanning tree; shortest path/route problem; The minimum spanning tree problem; The maximal flow problem.	5
6.	**Waiting line Problems:** Structure of a waiting line System: Single-channel waiting line, process of arrivals, distribution of service times, queue discipline, steady stage operation; Single channel model with Poisson arrivals and exponential service time; Multiple channel model with Poisson arrival and exponential service times; Single channel model with Poisson arrivals and arbitrary service time (M/G/1); Economic analysis of waiting lines	6
7.	**Non-Linear Programming:** Graphical illustration; Unconstrained optimization by (i) direct search method, (ii) steepest decent method; Constrained optimization by lagrange multipliers; Integer linear programming by branch & bound technique; Dynamic programming problems and their characteristics.	4

Recommended Books:

1. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. I.A. Taha, Operations Research: An Introduction, Pearson Publication
3. C.K. Musatfi, Operations Research, New Age International Publishers
4. S.S. Rao, Engineering Optimization, New Age International Publishers
5. R. Panneerselvam, Operations Research, Prentice Hall of India
6. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, The McGraw Hill Companies.

Paper Name: Materials Handling

Paper Code: ME 704 C Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction : Definition, importance and scope of materials handling (MH); classification of materials; codification of bulk materials ; utility of following principles of MH – (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time, (x) motion.	4
2.	Unit load : Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping.	3
3.	Classification of MH Equipment : Types of equipment – (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment..	4
4.	Industrial trucks & vehicles : Constructional features and use of the following equipment – (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck.	4
5.	Conveyors : Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of Flg. types of chain conveyors – (i) apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor.	8
6.	Hoisting Equipment : Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist , (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead traveling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane.	4
7.	Robotic handling: Materials handling at workplace; Major components of a robot;	2

	Applications of robotic handling, AGVs	
8.	Auxiliary Equipment: Descriptive specification and use of – (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vise; (v) ball table.	3

Recommended Books:

1. S. Ray, Introduction to Materials Handling, New Age Int. Pub.
2. T. K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd.
3. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors.
4. J.A. Apple, Material Handling System Design, John Wiley & Sons.

Other Electives II

Sl. No	Paper Code	Subject Name
1.	ME 705 A	ENERGY CONSERVATION & MANAGEMENT
2.	ME 705 B	QUALITY & RELIABILITY ENGINEERING
3.	ME 705 C	HYDRO, WIND AND WAVE POWER

Paper Name: Energy Conservation & Management

Paper Code: ME705 A Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	The Energy Resources; Finite & Renewable Sources	3
2.	The Need for Energy Conservation- estimation of Finite fuel resource; Hubbert's model for oil reserve	3
3.	Total Energy Concept- CHP Cycles & their applications	4
4.	Waste Heat Recovery; Waste Heat Exchangers; Commercial Waste Heat Recovery Devices- Recuperators, Regenerative Heat Exchangers, Heat Pipes	8
5.	Industrial Energy Conservation- Industrial Insulations; Case Studies for HVAC, Air Compressor, Mechanical Handling & Other Systems, Study of energy efficient methods	8
6.	Energy Audit; Basic Steps; Graphical representation; Case Studies	4
7.	The Economics of Energy Saving Schemes; Costs; investment analysis	4

Recommended Books:

1. Energy Management- Murphy WR, G Mckay- Butterworth Heinmann, 2007
2. Energy Mangement, Audit & Conservation-De Barun, , Vrinda Publications, Delhi, 2007
3. Eastop & Croft- Energy Efficiency, Longman, 1990
4. Turner- Energy management Handbook, 2nd Ed., Fairmont Press, 1993

Paper Name: Quality & Reliability Engineering

Paper Code: ME 705 B Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Management of Product Quality: Evolution of Quality Control; Changing Quality Concepts; Modern Concept of Total Quality Management; Contribution of Quality masters (Deming, Juran, Crosby, Ishikawa, Taguchi).	3
2.	Creating Quality by Design: Assessment of Customer's needs; Formulation of Design Specifications; Standardization; Costs of Quality; Quality Circles; 5-S concept;	4
3.	Total Quality Management: Concept of Total Quality, Difference between "Quality" Management and "Total Quality" Management, total quality maintenance, total quality in service sector; Role of Customer and People in Total Quality Management; Steps for Quality Improvement, Kaizen; Organizing for effective Quality Management;	4
4.	Process Control: Control Charts; Statistical Quality Control Tools; Statistical Process Control and Process Capability, Zero defect program; Six – Sigma approach;	4
5.	Quality Management Systems: ISO 9000 Series of Standard; ISO 14000 Series of Standards;	4
6.	Strategic tools and Techniques for TQM: Need for Tools and Techniques in TQM; Commonly used Tools for TQM; Approaches and Deployment of Tools for Quality Planning – Quality Function Deployment (QFD), concurrent engineering; Tools for continuous Improvement – Deming's Plan – Do – Check – Act (PDCA) cycle, Poka – Yoke (Mistake – Proofing), Taguchi's Quality Loss Function.	5
7.	Reliability: Concept and definition of reliability; Reliability Parameters: Reliability as a function of time, failure rate as a function of time, constant failure rate, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failure (MTBF), mean down time (MDT), maintainability & availability, increasing failure rate, bath-tub curve; Brief discussion on hazard models: constant hazard model, linearly increasing hazard model, nonlinear hazard model and weilbull distribution, Advantages of weibull distribution; System reliability models: series system, parallel system, series-parallel system.	6
8.	Risk Assessment & Reliability in Design: Causes of failures, Failure modes & Effects Analysis (FMEA), faulty tree analysis (FTA); Tribological failure and monitoring techniques; Design based on reliability, redundancy in design.	4

Recommended Books:

1. H. Lal, Total Quality Management – A Practical Approach – New Age International (P) Ltd. Publishers
2. S. K. Mondal –Total Quality Management Principles and Practice –Vikas Publishing House Pvt. Ltd.
3. A. V. Feigenbum– Total Quality Control, Mcgraw-Hill Book Company
4. Juran's Quality Control Handbook –McGraw Hill Book Company

5. Amitava Mitra, Fundamentals of quality Control and Improvement –- PHI

6. Grant and Leavenworth-Statistical Quality Control, 7th Edition, Tata Mcgraw Hill

7. E. Balaguruswamy , Reliability Engineering – TMH

8. Bhadury and Basu- Terotechnology: Reliability Engineering and Maintenance Management, Asian Books Pvt. Ltd.

9. Paul Kales- Reliability of Technology, Engineering and Management- PHI

Paper Name: HYDRO, WIND AND WAVE POWER

Paper Code: ME 705 C Contact Hours: 3L Credit: 3

Module No.	Syllabus	Contact Hrs.
1	Wind Energy Basics: Status, Advantages and disadvantages of wind energy systems, Advantages and disadvantages, Types of wind energy converters, local Effects on wind, Site selection: roughness length, wind shear, Wind Speed Variability, Obstacles to wind flow,	4
2	Working principles of wind energy: Energy content in wind, Energy Conversion at the Blade, Wind variations: Weibull distribution. Components of a wind energy converter: Rotor Blades, Gearboxes, Synchronous or Asynchronous Generators, Towers, Miscellaneous components, Turbine Selection	4
3	Operation and Control of Wind Energy Converters: grid requirements, Issue of Noise and Its Control, Power Curve and Capacity Factor, Pitch control, Stall Control, Yaw Control	4
4	Design of wind turbines- wind turbine design considerations, methodology, theoretical simulation of turbine loss, modelling of wind turbines and testing methods. mechanical and hydrochemical power transmission system, Aerodynamic and Mechanical Breaking, mechanisms and control. Dynamics of large wind turbine systems and associated instrumentation and control. Economics of wind energy utilization	6
5	Hydropower basics: Water Cycle in Nature, Classification of Hydropower Plants, Status of Hydropower Worldwide, Advantages and Disadvantages of Hydropower, Operational Terminology, Legal Requirements	4
6	Working principles: Locating a Hydropower Plant, Basics of Fluid Mechanics for hydro power, single and multiple reservoir system, cascaded power plants	4
7	Important Parts of Hydropower Station: Turbine, Electric Generator, Transformer and Power House, Structural parts: Dam and Spillway, Surge Chambers, Stilling Basins, Penstock and Spiral Casing, Tailrace, Pressure Pipes, Caverns, auxilliary parts.	5
8	Hydraulic turbines: Classification of Hydraulic Turbines, Theory of Hydro Turbines: Francis, Kaplan, Pelton turbines, efficiency and selection of turbine	5

Recommended Books:

1. Renewable Energy – G. Boyle, 2nd edition, OUP, 2010.

2. Renewable Energy Resources- Twidell, J & Weir, T, 2nd edition, Taylor & Francis, 2006.

3. Non Conventional Energy Resources- B.H. Khan, T M H, 2010.

4. Non Conventional Energy Sources- G.D. Rai, Khanna Publishers.

Paper Name: Advanced Manufacturing Technology Laboratory
Paper Code: ME791 Weekly Contact Hours: 3P Credit: 2

1) Programming study on CNC Turning machine.
2) Programming study on CNC Milling Machine
3) Study of geometry of robot manipulator, actuators and grippers
4) Robot Programming.
5) Parametric Study of Electric-Discharge Machining
6) Study of AJM/USM/ECM

Professional Electives Lab III

SL.No.	Paper Code	Subject Name
1.	ME 793 A	ADVANCED WELDING LAB
2.	ME 793 B	BIOMECHANICS & BIOMATERIALS LAB
3.	ME 793 C	FINITE ELEMENT METHOD LAB

Paper Name: ADVANCED WELDING LAB

Paper Code: ME 793A Weekly Contact Hours: 2P Credit: 1

List of Experiments:

1. At least 2 welding jobs to be produced using MIG
2. At least 2 welding jobs to be produced using TIG
3. 1 job from Brazing exercise
4. 1 job from Resistance welding

Paper Name: BIOMECHANICS AND BIOMATERIALS LAB

Paper Code: ME793B Weekly Contact Hours: 2P Credit: 1

List of Experiments:

1. Hardness testing of biomaterials
2. Measurement of torque required to tap and screwing in jaw bone.
3. Determination of moment of inertia of human limb using dynamometer.
4. Measurement of viscosity of body fluid.
5. Determination of moment of inertia of human bone using compound pendulum method.
6. Surface roughness measurement of biomaterials.

Paper Name: FINITE ELEMENT METHOD LAB

Paper Code: ME 793C Weekly Contact Hours: 2P Credit: 1

List of Experiments: At least 6 relevant problems need to be coded and solutions presented in graphical forms.

SESSIONAL COURSES

ME781
Project (Part I)
Contact Hours: 6P Credit: 3

Students in small groups will perform either an Industrial case study, or Preparation of a feasibility report, or Experimental investigation, or Computational/ Theoretical work, or Design and development of equipment/system. An industrial case study/ project, if undertaken by the student, is to be supervised jointly by industry personnel and a teacher. The task is to complete over a period of two semesters, and the progress of the work will be evaluated through presentation of the same in front of a panel of examiners followed by a viva voce examination.

ME782
Design of a Mechanical System
Contact Hours: 3P Credit: 2

In this sessional course work the students have to make design calculations and prepare component & assembly drawings/sketches (preferably in CAD) on a mechanical system assigned to a group of 4 to 5 students. Mechanical systems will include plants, quipment,instruments, drives, mechanisms, hydraulic/pneumatic/lubrication systems etc. The teachers will allocate one suitable mechanical system appropriate for a 8th. semester Mechanical Engineering student to each group of students.The students have to carryout the design work in consultation with the respective teacher/s and submit the designwork in bound volumes individually and face a viva voce examination as proof of their individual understanding of the design work.

ME783
Viva Voce on Vacational Training
Contact Hours: 0 Credit: 2

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SYLLABUS OF 8TH SEMESTER COURSES

Theory Courses

Paper Name: PRINCIPLE OF MANAGEMANT

Paper Code: HU(ME)801 Contact Hours: 2L Credit: 2

Module No.	Syllabus	Contact Hrs.
1	**Introduction** : System concept of production; Product life cycle; Types and characteristics of production system; Productivity; Process and product focused organization structures; Management decisions – strategic, tactical and operational	3
2	**Forecasting** : Patterns of a time series – trend , cyclical, seasonal and irregular; Forecasting techniques : moving average, simple exponential smoothing, linear regression; Forecasting a time series with trend and seasonal component.	4
3	**Materials Management and Inventory Control** : Components of materials management; Inventory control : EOQ model, Economic lot size model, Inventory model with planned shortages, Quantity discounts for EOQ model; ABC analysis; Just-in-time inventory management.	4
4	**Materials Requirement Planning** : MRP concept – bill of materials (BOM), master production schedule; MRP calculations.	3
5	**Machine Scheduling** : Concept of Single machine scheduling – shortest processing time (SPT) rule to minimize mean flow time, Earliest due date (EDD) rule to minimize maximum lateness, Total tardiness minimizing model; Minimizing makespan with identical parallel machines; Johnson's rule for 2 and 3 machines scheduling.	3
6	**Project Scheduling** : Activity analysis; Network construction; critical path method (CPM); Crashing of project network.	3
7	**Quality Assurance** : Meaning of Quality; Quality assurance system; choice of process and quality; Inspection and control of quality; Maintenance function & quality; Process control charts : x-chart and Rchart, p-chart and c-chart; Acceptance sampling : Operating characteristic (O.C) curve, Single sampling plan, Double sampling plan, Acceptance sampling by variables; concept of Six Sigma.	4

Books Recommended :

1. Buffa and Sarin, Modern Production/Operations Management, John Wiley & Sons.
2. R. Panneerselvam, Production and Operations Management, PHI.
3. Russell & Taylor, Operations Management, PHI.
4. Adam and Ebert, Production and Operations Management, PHI.
5. Production & Operations Management by Starr, Cenage Learning India.

Professional Electives IV

Sl. No.	Paper Code	Subject Name
1.	ME 802A	AUTOMOBILE ENGINEERING
2.	ME 802B	CAD/CAM
3.	ME 802C	AUTOMATION & CONTROL

Paper Name: Automobile Engineering

Paper Code: ME 802 A Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction: History & Development of Automobile. Various sub system of Automobile.	1
2.	Prime Mover: Engine for Two –Wheeler & Three- Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system.	5
3.	Auto Electrical: Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signaling	5
4.	Steering System: Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system.	3
5.	Transmission System: Flywheel & clutch. Gearbox sliding and constant mesh type, Automatic Transmission, Universal joint, Propeller shaft.	5
6.	Differential & Axle: Construction & function of differential, Different types of front & rear axles.	3
7.	Suspension System: Conventional and independent suspension system, application.	3
8.	Brake System: Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance.	3
9.	Power Requirement: Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation.	4
10.	Maintenance of Vehicle.	2

Recommended Books:

1. Motor Vehicle by Newton, Steed and Garrette 2nd ed, Butter worth.
2. Automobile Mechanics by N.K.Giri, 7th ed, Khanna Publishers.
3. Automobile Engineering by Amitosh De, Revised edition 2010, Galgotia Publication Pvt. Ltd.
4. Automobile Mechanics by Heitner Joseph, East West Press.

Paper Name: CAD/CAM

Paper Code: ME802B Contact Hours: 34L Credit: 3

Module	Syllabus	Contact

No.		Hrs.
1.	Fundamentals of CAD- Design process, benefits of computer aided design, graphics standards	3
2.	Geometric modeling- wire-frame, surface and solid modeling Transformation- translation and rotation exercise problems and programming	6
3.	Stress analysis- basics of FEM, formation of stiffness matrix for two elements.	6
4.	Introduction to computer aided manufacturing (CAM) systems, basic building blocks of computer integrated manufacturing (CIM).	4
5.	Toolings of CNC machines, tool and work handling systems involving robot, AGV, RTV, AS/RS, ATC, APC	3
6.	Robotics; types, anatomy, drives and applications.	3
7.	Computer aided production planning and control, Manufacturing from product design- CAD-CAM interface, concept of group technology (GT), CAPP.	6
8.	Control systems, Process monitoring, Adaptive control systems, etc.,	2
9.	Automatic inspection systems, use of CMM, Reverse Engineering.	1

Recommended Books:

1. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, TataMcGraw-Hill Publication.
2. M.P. Groover and E.W. Zimmers Jr., CAD/CAM, Prentice Hall of India
3. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, New Age International Publishers.
4. P.N. Rao, CAD/CAM, Tata McGraw Hill Publication.
5. M.P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall of India.
6. I. Zeid, CAD/CAM - Theory and Practice, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
7. S.R. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill Publication.
8. S.K. Saha, Introduction to Robotics, The McGraw-Hill Publication
9. P.B. Mahapatra, Computer-Aided Production Management, Prentice Hall of India.

Paper Name: AUTOMATION & CONTROL

Paper Code: ME 802 C Contact Hours: 3L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	**Introduction to control system:** Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servomechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function.	8

	Mathematical modeling of dynamic systems: Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. **Control system components:** Potentiometer, Synchros, Resolvers, Position encoders.	
2.	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. **Error Analysis:** Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.	8
3.	**State variable Analysis:** State variable model of Linear Time-invariant system, properties of the State transition matrix, State transition equation, Definition of transfer function & Characteristic equation, definition of controllability and observability.	8
4.	**Stability Analysis using root locus:** Importance of Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. **Frequency domain analysis of linear system:** Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. Mcircle and M-Contours in Nichols chart.	8
5.	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	4

**** Numerical problems to be solved in the tutorial classes.**

Text and Reference Books:

1. K. Ogata, Modern Control Engineering, 4th Edition, Pearson Education.
2. I. J. Nagrath and M. Gopal, Control System Engineering, New Age International Publication.
3. D. Roy Choudhury, Control System Engineering, PHI
4. B.C. Kuo and F. Golnaraghi, Automatic Control Systems, 8th Edition, PHI
5. Bandyopadhyaya, Control Engineering Theory & Practice, PHI
6. K.R. Varmah, Control Systems, Mc Graw hill
7. Norman Nise, Control System Engineering, 5th Edition, John Wiley & Sons

Open Electives III

Sl. No	Paper Code	Subject Name
1.	ME 803A	TURBO MACHINERY
2.	ME 803B	MAINTENANCE ENGINEERING
3.	ME 803C	NUMERICAL HEAT TRANSFER

Paper Name: TURBO MACHINERY

Paper Code: ME 803 A Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Classification: Incompressible and compressible flow machines; Radial, axial and mixed flow machines; Turbines vs pumps, fans and compressors. Applications: Water supply, ventilation, power generation, propulsion.	4
2.	Incompressible- Flow Machines: Hydraulic Turbines: Headrace, penstock, nozzle, runner, draft tube and tail race; Gross head and net head; Velocity diagrams for impulse and reaction turbines; Discharge, head, power and efficiencies. Pumps: Reservoir, foot valve, suction line, pump, delivery line and overhead tank; Static head and losses; Velocity diagrams; Discharge, head, power and efficiencies.	8
3.	Compressible-Flow Machines: Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary and moving blades; Efficiencies.	8
4.	Dimensional Analysis: Similarity laws, Volume-flow, mass-flow head and power coefficients, pressure ratio, enthalpy ratio, Reynolds number, Mach number; Specific speed and machine selection.	4
5.	Testing and Performance Analysis: Measurement devices; affinity laws and unit quantities. Set up and operating characteristics of pumps, turbines; fans and turbo-compressors. Cavitation– cause of cavitation and definition of Thoma's cavitation parameter, surge and choking.	8

Recommended Books:

1. S.M. Yahya, Turbine, Compressors and Fans.
2. J. Lal, Hydraulic Machines.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics & Fluid Machines, TMH.
4. M.M. Das, Fluid Mechanics & Turbo Machines, PHI, 2010.
5. R.K. Bansal, Fluid Mechanics & Machinery, Luxmi Publications.
6. C. Ratnam, A.V. Kothapalli, Fluid Mechanics & Machinery, I.K. International Publishing House Ltd, 2010.
7. C.S.P. Ojha, R. Berndtsson, P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press.
8. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publication.
9. A.T. Sayers, Hydraulic and Compressible Flow Turbomachines.
10. R.K. Bansal, Fluid Mechanics and Hydraulic Machines.

Paper Name: Maintenance Engineering

Paper Code: ME803B Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Definitions of repair and maintenance; Importance of maintenance; Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Maintainability, failure pattern, availability of equipment / systems,	8

	design for maintainability. Total Productive Maintenance (TPM): definition, objective & methodology; Implementation of TPM; Lean maintenance; Overall equipment effectiveness (OEE)	
2.	Organizational structures for maintenance: Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, Manpower planning; Engineering stores & inventory management.	4
3.	Economic Aspect of Maintenance: Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control; Maintenance audit- Procedure, tools, planning, reports.	4
4.	Function and use of Maintenance Equipment, Instruments & Tools: Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc.	6
5.	Lubrication: Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication devices, centralized lubrication system; Gasket, packing and seals;	4
6.	Repair & Maintenance Procedures: Repair of cracks, threads, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, electrical wiring, isolators and main switches, small induction motors; Steps for installation of a machine.	8

Recommended Books:

1. Mishra and Pathak, Maintenance Engineering and Management, PHI
2. Srivastava, Maintenance Engineering and Management, S. Chand & Company Ltd., New Delhi.
3. K. Venkataraman, Maintenance Engineering and Management, PHI

Paper Name: NUMERICAL HEAT TRANSFER

Paper Code: ME 803 C Contact Hours: 34L Credit: 3

Module	Syllabus	Contact Hrs.
1. Introduction Basics of heat transfer	Fluid flow. Mathematical description of fluid flow and heat 5 transfer: conservation equations for mass	5
2. Discretization techniques	Discretisation techniques using finite difference methods: Taylor Series and control volume formulations. Finite element discretization techniques.	4
3. Modelling of diffusion problems using finite volume method	One dimensional steady state diffusion problems; discretization technique. Solution methodology for linear and non-linear problems: Point-by-point iteration, TDMA. Two and three dimensional discretization. Discretization of unsteady diffusion problems: Explicit, Implicit and Crank-Nicolson's Implicit and Crank-Nicolson's algorithm; stability of solutions.	5

4. Modelling of ConvectionDiffusion Problems	One dimensional convectiondiffusion problem: Central difference scheme. Discretization based on analytical approach (exponential scheme). Hybrid and power law discretization 33echniques. Higher order schemes (QUICK algorithm).	5
5.Flow modelling	Discretization of incompressible flow equations. Pressure based algorithm: SIMPLE, SIMPLER etc.	5
6. Unstructured grids	Introduction to FVM with unstructured grids.	2
7. Multiphase problems	Modelling of multiphase problems: enthalpy method, volume of fluid (VOF) and Level Set Methods.	2
8. Introduction to turbulence modeling	Large Eddy Simulation (LES). Direct Numerical Simulation (DNS).	2
9. Projects / Exercises	Solving simplified problems: formulation, discretization with coarse grids, applying appropriate boundary and initial conditions and solving by hand calculations. Solving practical problems through software: writing user sub-routines; post-processing and interpretation of results.	4

References:

1. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow," Hemisphere Publishing Corporation, 1980. 2. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer," Hemisphere Publishing Corporation, 1984.
3. J. H. Ferziger and M. Peric, "Computational Methods for Fluid Dynamics", Second Edition, Springer, Berlin, 1999.
4. H. K. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman Scientific & Technical, 1 9 9 5.

Other Electives IV

Sl. No	Paper Code	Subject Name
1.	ME 804A	SAFETY & OCCUPATIONAL HEALTH
2.	ME 804B	NUCLEAR POWER GENERATION AND SUPPLY
3.	ME 804C	FRACTURE MECHANICS

Paper Name: Safety & Occupational Health

Paper Code: ME 804 A Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Development of industrial safety Developments in Occupational Health, Occupational Safety and Health in India	2
2.	Accidents and their prevention Theory of accident, Anatomy of an accident, How Accidents are Caused? , , Cost of Accidents, Principles of Accident Prevention, Techniques of Accident Prevention, Safe Work Environment, Housekeeping, Job Safety Analysis, Investigation of Accidents, Ergonomics,	6

	Personal Protective Equipment, Promotion of Health and Safety, Basic Safety Programming	
3.	Fire hazard Types of fire, Fire Hazards, Fire Explosion, fire prevention, Means of Escape in Case of Fire Inspection Safety Supervision Safety, Responsibility Safety Inspection, Fire prevention authorities, Rules Safety Training Safety Appraisal Safety Communication Safety Audit	4
4.	Occupational health and safety Occupational Health, Occupational Health Services in Places of Employment, Occupational Physician, Occupational Health in Developing Countries, Occupational Safety, Occupational Safety in Developing Countries, Promoting Occupational Health and Safety, Work Related Diseases, Occupational Health Hazards Recognition of Hazards, Industrial Hygiene, Occupational Diseases, basics of OHSAS 18001	6
5.	Health and safety at workplaces Health and Safety hazards, Occupational Health Requirements, Occupational Safety Requirements, Occupational Welfare Requirements, Abstracts and Notices, Obligations of a Worker, Obligations of Occupier, Personal protective equipment, Causes of Accidents, Prevention of Accidents, Safety Legislation, Safety Guidelines, emergency actions, related acts *(related to chemical processes, mines, workshop practices, construction work, electrical installations)*	6
6.	Health and safety management Basics of Safety management, Role of safety supervisor, planning for safety, Safety Policies, Safety Promotion, Safety Committee, safety education & training, Health and Safety Process, Measuring Safety, Risk Management and Loss Control	4
7.	Accident compensation Brief introduction to different acts - The Dangerous Machines (Regulations) Act, 1983, The Employers' Liability Act, 1938 The (Indian), Fatal Accidents Act, 1855 The Public Liability Insurance Act, 1991, The Workmen's Compensation Act, 1923, The Employees' State Insurance Act, 1948, Role of National Safety Council, International labour office	4

Recommended Books:

1. Safety management Systems, A. Waring, (Chapman & Hall,1996)
2. Environmental Health & Safety Management – A Guide to Compliance, N.P.Cheremisinoff, M.L.Graffia, (Noyes Publin. 2003)
3. Safety at Work, J.Ridley & J.Channing (5th. Edn.), (Butterworth & Heinemann, 2001)
4. Occupational Health & Hygiene, J.Stranks, (Pitman Publn., 1995)
5. Safety management: Strategy & Practice, R.Pybuss, (Butterworth & Heinemann, 1997)
6. Essentials of Safety management, H.L.Kalia, A.Singh, S.Ravishankar & S.V.Kamat, (Himalaya Publishing House, 2002)
7. Industrial Health & Safety Management, A.M.Sarma, (Himalaya Publishing House, 2002)

Paper Name: NUCLEAR POWER GENERATION AND SUPPLY

Paper Code: ME 804 B Contact Hours: 34L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Basics of a Nuclear Power Generation, energy from fission and fusion reactions	4
2.	Systems in nuclear reactor- Reactor fuel system: Natural and enriched fuels, sources, merits and demerits of different fuels for reactor use, fabrication, handling of fuels and irradiated fuels, fuel management, storage, reprocessing of irradiated fuels. Reactor shutdown systems: Materials for reactor control and choices, liquid vs. solid shut	10

	down systems, design aspects Primary heat transport (cooling) system: Heat generation and distribution, Coolant characteristics, Selection of coolants, Coolant Circuit, Core thermal hydraulics, Decay heat removal system. Reactor structure: Core composition, Reflector, Reactor vessel, Safety vessel, Shielding. Thermal, biological, Shield cooling system, Moderator system: Materials, Selection, Design consideration, Circuit, Radioactivity aspects. Cover gas system: Purpose, Selection of material, Design considerations, Circuit. Reactor regulating system: Purpose, Methodology, Design considerations, Actuating mechanism.	
3.	Reactor Design- Principles, Safety classifications, Seismic quality group, Loading considerations under normal operations, design basis accidents such as earthquake, loss of coolant accident (LOCA),blackout, flood, missiles, operator error, Safety features for server accidents, standards, soft ware, verifications etc.	6
4.	Nuclear power plants- Types .Thermal reactors: BWR, PWR, PHWR, GCR, APWR, AHWR etc. Fast reactors Breeders; Fusion power; Off-land NPPs:- space power unit, nuclear ships, submarines. Economics of NPPs: Various costs, ROI, Sizing, Operational characteristics.	6
5.	Radiation protection: Radiation hazard, Exposure pathways, dose unit, measurement, CRP Radioactive Waste Management: Waste categorization, Generation, Handling of wastes.	4
6.	Reactor Stages and Safety Assurances- Nuclear safety assurance.	4

Recommended Books:

1. A.K. Raja, A.P. Srivastava & M. Dwivedi, *An Introduction on Nuclear Engineering*,
2. Arora &Domkundwar, *A course in Power Plant Engg*-
3. P.K. Nag.- *Nuclear Power Plant, Power Plant Engg*. (Steam & Nuclear)
4. Glasstone & Sesons- *Nuclear Engineering*

Paper Name: FRACTURE MECHANICS

Paper Code: ME 804 C Contact Hours: 32L Credit: 3

Module No.	Syllabus	Contact Hrs.
1.	Basic modes of fracture, Griffith theory of brittle fracture, Irwin's modifications for elastic-plastic materials, theories of linear elastic fracture mechanics, stress intensity factors, fracture toughness testing.	6
2.	Crack-tip plasticity and elasto-plastic fracture mechanics in metals. Mixed mode problems and evaluation of critical fracture parameters. Classical theoretical analyses based on complex stress function approaches.	8
3.	Computational fracture mechanics: SERR evaluations, J-Integral methods.	4
4.	Fatigue damage theories, fatigue test, endurance limit, fatigue fracture under combined loading, fatigue controlling factors, effect of stress concentrations, notch sensitivity and cumulative fatigue damage concepts.	7

5.	Creep fracture: creep-stresstime temperature relations, creep relaxation theories; creep in tension, bending, torsion and combined loading; creep buckling; creep in piping and high temperature pressure vessel systems.	7

Recommended Books:

1. K. Ramesh, e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.
2. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
3. K. R.Y.Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001
4. D.Broek,Elementary Engineering Fracture Mechanics,Kluwer Academic Publishers, Dordrecht, 1986.
5. T.L.Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005

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SESSIONAL

ME881 Project : Part-II
Contact Hours: 12P Credit: 6

Students in small groups will perform either an Industrial case study, or Preparation of a feasibility report, or Experimental investigation, or Computational/ Theoretical work, or Design and development of equipment/system. An industrial case study/ project, if undertaken by the student, is to be supervised jointly by industry personnel and a teacher.
The task is to complete over a period of two semesters, and the final work will be submitted in the form of a printed hardcopy and will be evaluated through presentation of the same in front of a panel of examiners followed by a viva voce examination.

ME882 GRAND VIVA
Contact Hours: 0L Credit: 2

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