CURRICULUM

3rd – 8th Semester July 2018 admission onwards

APPROVED BY

BOARD OF STUDIES (BOS)

MEETING, February 20, 2019

BTech in Mechanical Engineering: Revised Teaching Scheme

DEPARTMENT OF MECHANICAL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY, JALANDHAR

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DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY

JALANDHAR

DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND DETAILED SYLLABI

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

EFFECTIVE FROM JULY, 2018 ONWARDS

CODING SCHEME FOR BTECH COURSES

The following scheme is the revised BTech Teaching scheme and curriculum applicable from 2018 admission onwards.

It has been proposed to have a 07 letters alpha numeric code for each course – XXYY-ABB. Wherein the first four letters are alphabets and next 03 are numerals.

XX, Code for Department which is offering course
YY Code regarding the type of course
A-Code representing the year in which the course is offered
BB- Code representing the course

Departmental Codes

S. No.	Department	Code
1	Bio Technology	BT
2	Civil Engineering	CE
3	Chemical Engineering	CH
4	Computer Science & Engineering	CS
5	Electrical Engineering	EE
6	Electronics & Communication Engineering	EC
7	Information Technology	IT
8	Instrumentation & Control Engineering	IC
9	Industrial & Production Engineering	IP
10	Mechanical Engineering	ME
11	Textile Engineering	TT
12	Chemistry	CY
13	Humanities & Management	HM
14	Mathematics	MA
15	Physics	PH
16	Student Welfare	SW

Course Codes

S. No.	Type of Courses	Code
1	Common Institute requirement	CI
2	Programme Core	PC
3	Programme Elective	PE
4	Open Elective	OE
5	Minor Elective	MI

SCHEME OF INSTRUCTION

BTech in Mechanical Engineering Course Structure

B. Tech. 1st YearSemester I

S. No.	Course Code	Course Title	L	T	P	C
1	PHCI-101	Applied Physics-A	3	1	0	4
2	MECI-101	Elements of Mechanical Engineering	3	1	0	4
3	CSCI-101	Computer Programming	3	0	0	3
4	MACI-101	Applied Mathematics-I	3	1	0	4
5	HMCI-101	Management, Principles & Practices	3	0	0	3
6	MECI-102	Engineering Graphics and CADD	1	0	4	3
7	PHCI-102	Applied Physics-A Lab	0	0	2	1
8	CSCI-102	Computer Programming Lab	0	0	2	1
		Total Credits	**16**	**3**	**8**	**23**

B. Tech. 1st Year Semester II

S. No.	Course Code	Course Title	L	T	P	C
1	CYCI-101	Applied Chemistry-A	3	1	0	4
2	MACI-102	Applied Mathematics-II	3	1	0	4
3	ICCI-101	Basic Electrical Science	3	1	0	4
4	HMCI-102	English Communication& Report Writing	3	0	0	3
5	IPCI-101	Manufacturing Processes	2	0	0	2
6	IPCI-102	Product Realization through Manufacturing Laboratory	0	0	4	2
7	HMCI-103	English Communication Lab	0	0	2	1
8	CYCI-103	Applied Chemistry-A Lab	0	0	2	1
9	CYCI-104	Environmental Studies	3	0	0	3
		Total Credits	**17**	**3**	**8**	**24**

Basic Engineering Courses Selected
(1) MECI-101 Elements of Mechanical Engineering
(2) ICCI-101 Basic Electrical Science

B. Tech. 2nd Year Semester III

S. No.	Course Code	Course Title	L	T	P	C
1	MEPC-201	Strength of Materials	3	1	0	4
2	MEPC-203	Theory of Machines	3	0	0	3
3	MEPC-205	Machine Drawing	1	0	6	4
4	MEPC-207	Applied Thermodynamics-I	3	1	0	4
5	MEPC-209	Material Science and Metallurgy	3	0	0	3
6	MEPC-211	Fluid Mechanics-I	3	1	0	4
7	MEPC-213	Strength of Material and Material Characterization Lab	0	0	2	1
8	MEPC-215	Theory of Machines Lab	0	0	2	1
		Total Credits	**16**	**3**	**10**	**24**

B. Tech. 2nd Year Semester IV

S. No.	Course Code	Course Title	L	T	P	C
1	MEPC-202	Applied Thermodynamics-II	3	1	0	4
2	MEPC-204	Dynamics of Machines	3	1	0	4
3	MEPC-206	Mechanics of Deformable Bodies	3	1	0	4
4	MEPC-208	Production Processes	3	0	0	3
5	MEPC-210	Fluid Mechanics-II	3	1	0	4
6	MACI-201	Mathematics-III	3	1	0	4
7	MEPC-214	Production Processes Lab	0	0	2	1
		Total Credits	**18**	**5**	**2**	**24**

B. Tech. 3rd Year Semester V

S. No.	Course Code	Course Title	L	T	P	C
1	MEPC-301	Design of Machine Elements-I	3	0	0	3
2	MEPC-303	Heat Transfer	3	0	0	3
3	MEPC-305	I. C. Engines and Emission Control	3	0	0	3
4	MEPC-307	Mechanical Measurement & Metrology	3	0	0	3
5	MEPC-309	Mechatronics	3	0	0	3
6	HMCI-202	Entrepreneurship Development and Management	3	0	0	3
7	MEPC-311	Applied Thermodynamics Lab	0	0	2	1
8	MEPC-313	Design of Machine Elements-I Lab	0	0	2	1
9	MEPC-315	Heat Transfer Lab	0	0	2	1
10	MEPC-317	Mechanical Measurement & Metrology Lab	0	0	2	1
11	MECI-300	Minor Project, Phase-I	0	0	2	0*
		Total Credits	**18**	**0**	**8**	**22**

*** Minor Project, to be allotted in beginning of 5th Semester, evaluation at the end of 6th Semester**

B. Tech. 3rd Year Semester VI

S. No.	Course Code	Course Title	L	T	P	C
1	MEPC-302	Fluid Machinery	3	0	0	3
2	MEPC-304	Industrial Automation	3	0	0	3
3	XXOE-XXX	Open Elective-I	3	0	0	3
4	MEPE-3XX	Programme Elective-I	3	0	0	3
5	MEPC-306	Design of Machine Elements-II	3	0	0	3
6	MEPC-308	Numerical Methods in Mechanical Engineering	3	0	0	3
7	MEPC-310	Fluid Mechanics and Fluid Machinery Lab	0	0	2	1
8	MEPC-312	Industrial Automation & Mechatronics Lab	0	0	2	1
9	MEPC-314	Design of Machine Elements-II Lab	0	0	2	1
10	MECI-300	Minor Project, Phase-II	0	0	2	2
		Total Credits	**18**	**0**	**8**	**23**

B. Tech. 4th Year Semester VII

S. No.	Course Code	Course Title	L	T	P	C
1	MEPC-401	Refrigeration and Air Conditioning	3	0	0	3
2	MEPC-403	Vibrations and Control	3	0	0	3
3	MEPE-4XX	Programme Elective-II	3	0	0	3
4	MEPE-4XX	Programme Elective-III	3	0	0	3
5	XXOE-XXX	Open Elective-II	3	0	0	3
6	MECI-411	Industrial Lecture*	1	0	0	1
7	MECI-400	Major Project (Phase –I)	0	0	4	0**
8	MEPC-405	Refrigeration and Air Conditioning Lab	0	0	2	1
9	MEPC-407	Vibrations and Control Lab	0	0	2	1
10	MECI-413	Industrial Practical Training	0	0	0	2#
		Total Credits	**17**	**0**	**8**	**20**

***** Minimum 04 Industrial lectures to be organised by department in final year of study. Grades to be awarded based upon Quiz test on the same day of lecture

** Major Project, to be allotted in beginning of 7th Semester, evaluation at the end of 8th Semester

Industrial Practical Training will be held during summer vacation after sixth semester

B. Tech. 4th Year Semester VIII

S. No.	Course Code	Course Title	L	T	P	C
1	MEPC-402	CAD/CAM	3	0	0	3
2	MEPE-4XX	Programme Elective-IV	3	0	0	3
3	MEPE-4XX	Programme Elective-V	3	0	0	3
4	MEPE-4XX	Programme Elective-VI	3	0	0	3
5	XXOE-XXX	Open Elective-III	3	0	0	3
6	MECI-400	Major Project (Phase –II)	0	0	8	4
7	MEPC-404	CAD/CAM Lab	0	0	2	1
		Total Credits	**15**	**1**	**10**	**20**

LIST OF MECHANICAL ENGINEERING PROGRAMME ELECTIVES

PROGRAMME ELECTIVES FOR 3rd YEAR						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MEPE-301	Alternate Fuels For IC Engines	3	0	0	3
2	MEPE-302	Flexible Manufacturing System	3	0	0	3
3	MEPE-303	Lubrication and Wear	3	0	0	3
4	MEPE-304	Mechanics of Composite Material	3	0	0	3
5	MEPE-305	Occupational Safety and Environment	3	0	0	3
6	MEPE-306	Operation Management	3	0	0	3
7	MEPE-307	Operations Research	3	0	0	3
8	MEPE-308	Power Plant Engineering	3	0	0	3
9	MEPE-309	Product Design and Development	3	0	0	3
10	MEPE-310	Production Management	3	0	0	3
11	MEPE-311	Production Planning and Control	3	0	0	3
12	MEPE-312	System Dynamics & Control	3	0	0	3
13	MEPE-313	Total Quality Management	3	0	0	3

PROGRAMME ELECTIVES FOR 4th YEAR						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MEPE-401	Automobile Engineering	3	0	0	3
2	MEPE-402	Combustion Generated Pollution and Control	3	0	0	3
3	MEPE-403	Computational Fluid Dynamics	3	0	0	3
4	MEPE-404	Control Theory and Applications	3	0	0	3
5	MEPE-405	Cryogenics	3	0	0	3
6	MEPE-406	Design for Production	3	0	0	3
7	MEPE-407	Energy Management	3	0	0	3
8	MEPE-408	Experimental Stress Analysis	3	0	0	3
9	MEPE-409	Fundamentals of Combustion	3	0	0	3
10	MEPE-410	Introduction to Finite Element Methods	3	0	0	3
11	MEPE-411	Materials and Environment	3	0	0	3
12	MEPE-412	Materials and Sustainable Development	3	0	0	3
13	MEPE-413	Materials in Mechanical Design	3	0	0	3
14	MEPE-414	Metal Cutting and Machine Tools	3	0	0	3
15	MEPE-415	Metal Forming	3	0	0	3
16	MEPE-416	Microfluidics and Nanofluidics	3	0	0	3
17	MEPE-417	Modal Analysis of Mechanical Systems	3	0	0	3
18	MEPE-418	Next Generation Automotive Mobility Engineering	3	0	0	3
19	MEPE-419	Noise Engineering	3	0	0	3
20	MEPE-420	Non-Conventional Energy	3	0	0	3

21	MEPE-421	Numerical Control for Machine Tool	3	0	0	3
22	MEPE-422	Numerical Heat Transfer	3	0	0	3
23	MEPE-423	Robotics: Mechanics and Control	3	0	0	3
24	MEPE-424	Solar Thermal Process	3	0	0	3
25	MEPE-425	System Design	3	0	0	3
26	MEPE-426	Theory of Elasticity	3	0	0	3
27	MEPE-427	Theory of Plasticity	3	0	0	3
28	MEPE-428	Tool Design	3	0	0	3
29	MEPE-429	Unconventional Methods of Machining	3	0	0	3
30	MEPE-430	Vibro-Acoustics	3	0	0	3
31	MEPE-431	Welding and Allied Processes	3	0	0	3

List of Minor Electives for B Tech Minor degree courses for other branch students.

B. Tech. Minor Degree Electives						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MEMI-201	Thermo-Fluidics	3	0	0	3
2	MEMI-202	Strength of Materials	3	0	0	3
3	MEMI-301	Applied Thermal Engineering	3	0	0	3
4	MEMI-302	Theory of Machines	3	0	0	3
5	MEMI-401	Fluid Machines	3	0	0	3
6	MEMI-402	Design of Machine Elements	3	0	0	3
		Total Credit	**18**	**0**	**0**	**18**

LIST OF OPEN ELECTIVES FOR B. TECH STUDENTS

OPEN ELECTIVES FOR 3rd YEAR						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MEOE-351	Mechanics of Composite Material	3	0	0	3
2	MEOE-352	Occupational Safety and Environment	3	0	0	3
3	MEOE-353	Operation Management	3	0	0	3
4	MEOE-354	Operations Research	3	0	0	3

5	MEOE-355	Product Design and Development	3	0	0	3
6	MEOE-356	Production Management	3	0	0	3
7	MEOE-357	Production Planning and Control	3	0	0	3

OPEN ELECTIVES FOR 4th YEAR						
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	MEOE-451	Automobile Engineering	3	0	0	3
2	MEOE-452	Computational Fluid Dynamics	3	0	0	3
3	MEOE-453	Finite Element Methods	3	0	0	3
4	MEOE-454	Materials and Environment	3	0	0	3
5	MEOE-455	Materials and Sustainable Development	3	0	0	3
6	MEOE-456	Metal Cutting And Machine Tools	3	0	0	3
7	MEOE-457	Non-Conventional Energy	3	0	0	3
8	MEOE-458	Robotics: Mechanics And Control	3	0	0	3
9	MEOE-459	Solar Thermal Process	3	0	0	3

DETAILED SYLLABI OF ALL SUBJECTS

PHCI-101	Applied Physics-A	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO1	After completing the course students should know about the need of quantum mechanics. They should know about dual character of radiations as well as matter, about the Heisenberg uncertainty principle, the concept of wave function and about Schrodinger wave equation and its applications to simple one dimensional potential problem.
CO2	Student should know basics of vector calculus and how to use that in electricity and magnetism. They should have knowledge of four Maxwell equations and their Physical significance.
CO3	Students are expected to know about the special theory of relativity and how it is different from Newtonian theory. They should have knowledge about various interesting consequences of special theory of relativity and about Einstein mass energy relationship.
CO4	Student should know different types of crystal system, about Miller indices and their use and about different types of defects in the crystals.
CO5	Students will learn about the strength of materials, the processes leading to failure in materials and creep mechanism.
CO6	Student will be familiar with the laws of thermodynamics, difference between classical and quantum statistical mechanics, application of statistical mechanics to calculate the specific heats of solids and for free electron gas.

Detailed Syllabus

UNIT-I

Quantum Theory: Need of Quantum theory, Photoelectric effect, The Compton effect; matter waves, group and phase velocities; Uncertainty principle and its application; time independent and time dependent Schrödinger wave equation; Eigen values and Eigen functions, Born's interpretation and normalization of wave function, orthogonal wave functions; applications of Schrödinger wave equation for particle in one dimensional infinite potential well.

(08 Lectures)

UNIT-II

Electromagnetism: Gradient of a scalar, divergence and curl of a vector; electric potential due to arbitrary continuous charge distribution, multipole expansion; dielectrics: polarization, Gauss law in dielectrics, electric displacement, susceptibility & permittivity; continuity equation, derivation of integral and differential forms of Maxwell equations and their physical significance; EM waves in free space.

(10 Lectures)

UNIT-III

Theory of Relativity: Galilean transformations, Galilean Invariance, concept of ether; Michelson-Morley experiment; Einstein's postulates and Lorentz transformation equations, Consequences of Special Theory of relativity: length contraction, Time dilation, and simultaneity of events, addition of velocity, variation of mass with velocity, mass-energy relation, energy-momentum relation. **(08 Lectures)**

UNIT-IV

Crystal Structure: Fundamental concepts, Crystal systems, Closed packed structures, Crystallographic planes and directions, Miller indices, Crystal defects. **(06 Lectures)**

UNIT-V

Mechanical Properties: The elastic properties, model of elastic behavior, plastic deformation tensile stress-strain curve, shear strength of perfect and real crystals, mechanical failure, fatigue and fracture, creeps: mechanism of creep, characterization of creep curves. **(06 Lectures)**

UNIT-VI

Thermal Physics: Seebeck effect, Peltier effect, Thomson effect, Kelvin relationships, Wiedemann-Franz law, Thermal equilibrium, Entropy, The laws of thermodynamics, thermal conductivity of bulk materials, Phonons: lattice vibration heat transfer, specific heat of solids, classical, Einstein and Debye Model, Ideal quantum gases: Maxwell-Boltazmann, Bose-Einstein, Fermi-Dirac statistics, Carnot efficiency. **(06 Lectures)**

Books Recommended:

1. A. Beiser, "Concepts of Modem Physics", McGraw Hill, New Delhi, 6th Ed. (2002).
2. K S Krane, "Modern Physics", John Wiely & Sons, Inc., 3rd Ed. (2011).
3. Raymond A Serway"Modern Physics", Thomson, 3rd Ed.
4. D. J. Griffiths, "Introduction to Electrodynamics", Prentice Hall of India, New Delhi, 2nd Ed. (1998).
5. H K Malik & A K Malik, "Engineering Physics", McGraw Hill Education, 2nd Ed. (2017).
6. Callister W.D. "Material Science and Engineering", John Wiley & Sons, Inc. New York, (1997).
7. V. Raghavan "Introduction to Material Science and Engineering", Prentice Hall of India.
8. Daneil V Schroedar, "Introduction to Thermal Physics", Pearson, India (2014).
9. Stephen J. Blundell and Katherine M. Blundell, "Concepts in Thermal Physics", Oxford, Indian Ed. (2014).

MECI-101	Elements of Mechanical Engineering	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO1	Emphasis laid upon the principles and fundamentals involved in the inter-conversion of thermal energy into mechanical energy and vice versa.
CO2	The subject also offers a birds eye-view to all students about the common engineering materials finding vide application in Mech. Engg. Industry and about their strength and other related vital aspects.
CO3	Understand the basic concepts of fundamental of fluid mechanics and thermodynamics.
CO4	To understand basic principle of engineering mechanics to design and analyze various types of structural elements.

Detailed Syllabus

Part-I: Solid Mechanics

Introduction: System of forces, coplanar concurrent force system, composition and resolution of force, equilibrium of rigid bodies, free body diagram, Lami's theorem.

Analysis of framed structure: Reaction in beam with different end conditions, determination of reactions in members of trusses: a) Analytical methods b) Graphical method

Centre of gravity and moment of inertia: Concept of C.G and centroid, position of centroid, theorem of parallel and perpendicular axes, moment of inertia of simple geometrical figures.

Stress and strain: Concept of stress and strain, simple stresses, tensile, compressive, shear, bending and torsion, stress- strain curves, elongation of bars, composite bars, thermal stresses, elastic constants.

Part- II Basis of Thermal and Fluid Science

Thermal Science: Introduction and scope of thermodynamics, thermodynamics properties, forms of energy, thermodynamic systems and control volume, steady flow systems, types of work, thermodynamic processes, laws of thermodynamics, Carnot theorem, concept of entropy.

Fluid and their properties: Ideal and real fluids, capillarity, Vapour pressure, compressibility and bulk modulus, Newtonian and non-Newtonian fluids.

Fluid Statics: Concept of pressure, Pascal's law and its engineering applications, action of fluid pressure on a plane (horizontal, vertical and inclined) submerged surface, resultant force

and centre of pressure, Buoyancy and flotation, stability of floating and submerged bodies, Metacentric height.

Fluid Kinematics: Classification of fluid flows, velocity and acceleration of fluid particle, normal and tangential acceleration, streamline, path line and streak line, flow rate and discharge mean velocity, continuity equation, Euler's equation, Bernoulli's equation and its applications and steady flow energy equation.

Books Recommended

1. Engg. Thermodynamics by P.K Nag, Tata McGraw- Hill education, 01- April- 2005.

2. Thermodynamics: An Engg. Approach by Yunus A. Cengel, Michael Boles, Tata McGraw- Hill Education, 2006.
3. Engineering Mechanics: Statics and Dynamics, N. H. Dubey, Tata McGraw-Hill Education, 2013.
4. Fluid Mechanics: Fundamentals and Applications- by Yunus A. Cengel, John M Cimbala, Tata McGraw- Hill Series in Mechanical Engg.

CSCI-101	Computer Programming	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Develop simple applications in c using basic constructs
CO 2	Design and implement applications using arrays and strings
CO 3	Develop applications in c using functions, pointers and structures.

Detailed Syllabus

Basics of C Programming
Introduction to programming paradigms, Structure of C program, C programming: Data Types, Storage classes, Constants, Enumeration Constants, Keywords, Operators: Precedence and Associativity, Expressions, Input/Output statements, Assignment statements, Decision making statements, Switch statement, Looping statements, Pre-processor directives, Compilation process

Arrays and Strings
Introduction to Arrays: Declaration, Initialization, One dimensional array, Example Program: Computing Mean, Median and Mode, Two dimensional arrays, Example Program: Matrix Operations (Addition, Scaling, Determinant and Transpose), String operations: length, compare, concatenate, copy, Selection sort, linear and binary search.

Functions and Pointers
Introduction to functions: Function prototype, function definition, function call, Built-in functions (string functions, math functions), Recursion, Example Program: Computation of Sine series, Scientific calculator using built-in functions, Binary Search using recursive functions – Pointers, Pointer operators, Pointer arithmetic, Arrays and pointers, Array of pointers, Example Program: Sorting of names, Parameter passing: Pass by value, Pass by reference, Example Program: Swapping of two numbers and changing the value of a variable using pass by reference.

Structures
Structure, Nested structures, Pointer and Structures, Array of structures, Example Program using structures and pointers, Self-referential structures, Dynamic memory allocation, Singly linked list typedef.

File Processing
Files, Types of file processing: Sequential access, Random access, Sequential access file, Example Program: Finding average of numbers stored in sequential access file, Random

access file, Example Program: Transaction processing using random access files, Command line arguments

TEXT BOOKS, AND/OR REFERENCE MATERIAL:

1. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", first Edition, oxford university press, 2009
2. Ashok N. Kamthane, "Computer Programming", pearson education, 2007.
3. Yashavant p. Kanetkar. "Let us C", bpb publications, 2011
4. Kernighan,B.W and Ritchie,D.M, "The C Programming Language", second edition, Pearson education, 2006.
5. Byron S Gottfried, "ProgrammingWith C", schaum's outlines, second edition, tata Mcgraw-hill, 2006.
6. R.G. Dromey, "How to Solve it by Computer", pearson education, fourth reprint, 2007

MACI-101	Applied Mathematics-I	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To develop skill of higher derivative, expansion of functions in ascending power of variable & value of the function in neighboured of some points.
CO 2	To determine limits of indeterminate function applicable to already word problems & engineering problems.
CO 3	To gain the knowledge to solve differential equation arising in different Engineering branch and able to form mathematical & physical interpretation of its solution which place important role in all branches of engineering.
CO 4	To demonstrate the basic concepts in Fourier series, properties, parseval's identity.
CO 5	To apply the concepts of Fourier and integral transform.
CO 6	To develop the concepts of Laplace transformation & inverse Laplace transform with its property to solve partial differential equation and ordinary differential equation with given boundary conditions which is helpful in all engineering & research work.
CO 7	To develop the concepts of Z-Transform and its application.

Detailed Syllabus

Formation of ordinary differential equations, solution of first order differential equations by separate of variables, homogeneous equations, exact differential equations, equations reducible to exact form integrating factors, equations of the first order and higher degree. Clairaut's equation

Linear differential equations with constant coefficients, Cauchy's homogeneous linear equation Legendre's linear equation, simultaneous linear equations with constant coefficients.

Fourier series of periodic functions, even and odd functions, half range expansions and Fourier set of different wave forms, complex form of Fourier series and practical harmonic analysis.

Laplace transforms of various standard functions, properties of Laplace transforms and inverse Laplace transforms, Convolution theorem, Laplace transforms of unit step function, impulse function in periodic functions, application to solution of ordinary differential equations with constant coefficient and simultaneous differential equations.

Z-transform and difference equations.Elementary properties of z-transform.Convolution theorem formation of difference equations using z-transform.

Fourier transforms, Fourier integral theorem. Fourier sine.Cosine integrals and transforms. Fourier transforms of derivatives of a function, convolution theorem. Parseval's indentity.

Books Recommended:

1. E Kreyszig, "*Advanced Engineering Mathematics*", 8th Ed., John Wiley, Singapore (2011).
2. R.K.Jain and S R K Iyengar, "*Advanced Engineering Mathematics*", 2nd Ed., Narosa Publishing House, New Delhi (2003).
3. B.S. Grewal, "*Higher Engineering Mathematics*", 35thEd. Khanna Publishers, Delhi.

HMCI-101	Management, Principles & Practices	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students will be able to understand the basic concept of the management, its nature and its relevance in the practical world.
CO 2	Students will also be able to understand the basic role of the management in the success of an organization. A student will also be able to understand the history of the evolution of the management which is nowadays established a so profession.
CO 3	Students will also be able to have a sense of the management process which starts with planning and ends with a success and strong control.
CO 4	Develop awareness about the social environment its impact on the common human beings and the psychological factors which influences a strong motivational in an individual.
CO 5	Develop a strategy for transition into a universal human order at the individual level as well as at the level of the responsible society.
CO 6	Develop group behaviour and team building skills, handle out stress and conflict resolution.
CO 7	Imbibe a positive learning attitude with cognition, emotional intelligence and a learned attitude.

Detailed Syllabus

Unit 1- Introduction of Management [8 Lectures]
What is Management, Roles and skills of a manager, Universality of Management, Management- A Science or an Art, overview of Management functions, Management Styles- Japanese, American, and Indian, Management as a function

Unit 2- Historical Background of Management [8 Lectures]
Scientific Management- Contribution of F W Taylor, General Administrative theory- 14 principles of Henry Fayol, Bureaucracy- Max Weber Contribution, Human Relationship Approach- Elton Mayo contribution through Hawthorne experiments, McGregor theory X and Y, Contribution of Peter Drucker

Unit 3 – Planning and Organising [10 Lectures]
What is planning and its purpose, Planning process, types of plans, criticism of planning, Departmentalization- Purpose and Basis, Span of Control, Centralization v/s Decentralisation, traditional and contemporary Organisational Design

Unit 4- Staffing and Leading [12 Lectures]
Importance of HRM, Human Resource planning, Recruitment- Methods, Selection process, Motivating employees- Maslow's need hierarchy theory, Herzberg two factor theory, three need theory, Vroom Expectancy theory, Leadership theories- Trait theory, Fiedler Model, Hersey and Blanchard Situational leadership, Path Goal theory, Managerial grid theory, Leadership Styles, Transformational v/s Transactional Leadership, Group v/s Team, Group Formation Stages

Unit 5- Co-ordination, Conflict and Controlling [6 Lectures]
Authority v/s Responsibility, Co-ordination v/s Co-operation, Importance of Co-ordination, Conflict- types of Conflict, resolving conflicts, Controlling- importance, controlling process, controlling techniques

Books Recommended

1. Koontz, Hand Weilhrich H, "Essentials of Management", 10th Edition, Tata McGraw Hill
2. Robbins, Stephen P, Coutler, Mary, "Management" 8th Edition, Pearson
3. Prasad, L M, "Principles and Practices of Management", 6th Edition, Sultan Chand
4. Stoner, J A F, Freeman R E, Gilbert, D R, "Management" 6th Edition, Pearson

MECI-102	Engineering Graphics and CADD	Core Course	L	T	P	Credit
			1	0	4	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students will be able to acquire knowledge of different conventions and methods of engineering drawing.
CO 2	Student's capability to generate and draw various geometric constructions & engineering objects (2D & 3D) with different drawing tools will upgrade.
CO 3	Students will enhance their imagination and conceptualization skills so as to impart this knowledge in designing and development of various objects.
CO 4	Knowledge gained will further help students for future project works.

Detailed Syllabus

Introduction: Engineering Graphics/Technical Drawing– a Visual Science. Types of Engineering Drawing, Introduction to drawing equipment and use of instruments, Application of Symbols and conventions in drawing Practice. Types of lines and their use, BIS codes for lines, Technical lettering as per BIS codes, Introduction to dimensioning, Concepts of scale drawing, Types of scales.

Theory of Projections: Relevance of projection, Theory of projections, Perspective, Orthographic, Axonometric and their basic principles, system of orthographic projection: in reference to quadrants and octants, illustration through simple problems of projection.

Projection of Points: Projection in quadrants and octants, Projection of point on auxiliary planes.

Projection of Lines: Parallel to both H P and V P, Parallel to one and inclined to other, Contained in profile plane, Other typical cases: three view projection of straight lines, true length and angle orientation of straight line: rotation method and auxiliary plane method, Distance between two non-intersecting lines, trace of line.

Projection of Planes: Difference between plane and lamina, Projection of lamina, Parallel to one and perpendicular to other, Perpendicular to one and inclined to other, Inclined to both reference planes, Plane oblique to three reference planes, application of auxiliary planes, trace of planes.

Projection of Solids: Definition of solids, types of solids, and elements of solids, Projection of solids in first or third quadrant, Axis parallel to one and perpendicular to other, Axis parallel to one inclined to other, Axis inclined to both the principle plane, Axis perpendicular to profile plane and parallel to both H P and V P, visible and invisible details in the projection, Use of rotation and auxiliary plane method.

Section of Solids: Definition of Sectioning and its purpose, Procedure of Sectioning, Illustration through examples, Types of sectional planes-application to few examples.

Intersection of Surfaces/Solids: Purpose of intersection of surfaces, Intersection between the two cylinder, two prisms, prism and pyramid, pyramid and pyramid, cylinder and prism, cone and cylinder, sphere and cylinder etc., use of cutting plane and line method.

Development of Surface: Purpose of development, Parallel line, radial line and triangulation method, Development of prism, cylinder, cone and pyramid surface for both right angled and oblique solids, Development of surface.

Isometric Projection: Classification of pictorial views, Basic Principle of Isometric projection, Difference between isometric projection and drawing, Isometric projection of solids such as cube, prism, pyramid and cylinder, Discussion on isometric projection of simple machine parts.

Orthographic Projection: Review of principle of Orthographic Projection, Examples of simple machine parts, Drawing of Block and machine parts.

Introduction to CADD: Interfacing and Introduction to CAD Software, Coordinate System, 2D drafting: lines, circles, arc, polygon, etc., Dimensioning, 2-D Modelling, Use of CAD Software for engineering drawing practices.

Books Recommended for Engineering Drawing

1. Bhatt N.D., "Engineering Drawing", 53rd Ed., Charotar Publishing House Pvt. Ltd., Gujarat (2017).
2. Gill P.S., "Engineering Drawing", 2013 Ed., S.K Kataria & Sons, New Delhi, 2013.
3. Frederick E. Giesecke, Shawna Lockhart, Marla Goodman, Cindy M. Johnson,
4. "Technical Drawing with Engineering Graphics", 15th Ed., Prentice Hall, USA, 2016.
5. M.B. Shah, B.C. Rana, "Engineering Drawing", 3rd Ed., Pearson Education, New Delhi, 2009.
6. Kirstie Plantenberg, "Engineering Graphics Essentials-Text and Digital Learning", 5th Ed., SDC Publications, USA (2016).

PHCI-102	Applied Physics-A Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students will learn about the application and working of basic semiconductor devices.
CO 2	Students will learn about various aspects of waves.
CO 3	Students will learn about the thermal properties of materials.
CO 4	Students will learn how to experimentally calculate some of the quantities related to quantum physics.
CO 5	Students will learn about basics of experimental electromagnetism.
CO 6	Students will learn to use experimental set-up to calculate the elastic constants of materials and to study their mechanical properties.

List of Experiments

1. To verify the laws of vibrating strings by Melde's experiments that is to show that $\lambda 2/T$ =constant.
2. To determine the impedance of A.C. Circuits.
3. To study the characteristic of PN diode and Zener diode.
4. To find out the intensity response of a solar cell/Photo diode.
5. To analyze the suitability of a given Zener diode as a power regulator.
6. To determine the band gap of a semiconductor.
7. To study the effect of voltmeter resistance on voltage measurement.
8. To study the variation of magnetic field with distance along the axis of a circular coil

carrying current and its estimate the radius of the coil.
9. To determine Planck's constant by LED method.
10. To determine the resistivity of a semiconductor by four probe method.
11. To confirm the de Broglie equation for electrons.
12. To find the coefficient of thermal conductivity of bad conductor by Lee's disc method.
13. To find Young's modulus, modulus of rigidity and Poisson's ratio for the material of a given wire by Searle's method.
14. To investigate creep of a copper wire at room temperature.
15. To determine the Hall coefficient of a semiconductor and hence to estimate the charge carrier concentration.

Books Recommended:
1. R S Sirohi "Practical Physics" Wiley Eastern, New Delhi.
2. C L Arora "B.Sc. Practical Physics", S Chand & Company

CSCI-102	Computer Programming Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To introduce the concepts of structured Programming language.
CO 2	To introduce the concepts of pointers and files
CO 3	To introduce the concepts of primitive Data Structures.

List of Experiments

1. C Programs using simple statements and expressions.
2. C Programs for scientific problem solving using decision making and looping.
3. C Programs for the implementation of simple one dimensional array and its various operations.
4. C Programs for the implementation of two dimensional arrays and its various operations.
5. C Programs for solving problems using String functions.
6. C Programs for the implementation of user defined functions and their operations.
7. C Programs using recursive function.
8. C Programs using structures.
9. C Programs using Pointers.
10. C Programs for file handling operations.

CYCI-101	Applied Chemistry-A	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To understand the solid state chemistry of the materials along with the distribution of solvents and their application in solvent extraction.
CO 2	To understand the phase transitions of different compositions of the elements, alloys and interpret the phase diagram of phases present.
CO 3	To study the spectra of compounds and propose the structures of the compounds along with applications of the spectroscopy in various fields.
CO 4	To study the reaction mechanisms of the various reactions and use of various reagents. To understand the shape and structure, stability, magnetic properties, and applications of coordination complexes.
CO 5	To examine the role of metals in biology, the study biological processessuch as respiration, oxygen transport, role of Myoglobin and Hemoglobin and metal properties in biological chemistry.
CO 6	To understand the basic concept of Nanochemistry along with fabrication, characterization and application of nanomaterials.
CO 7	To identify and formulate the conducting polymers and their applications in different fields.

Detailed Syllabus

Part-A

Phase Equlibria & Distribution Law: Phase diagram for single component system, carbon dioxide system, sulphur system, carbon system, helium system, Two component systems: Pb-Ag system, Bi-Cd system, Kl-H2O system, Iron Carbon Equilibrium diagram, Iron Allotropy, Micro Constituents of Iron and Steel

Structural elucidation of engineering Materials: Lambert-Beer's Law, Principles and applications of U. V. Visible, Molecular Absorption Spectroscopy, Chromophore, Effect of conjugation on chromophore, Absorption by aromatic systems, Rotational and Vibrational spectroscopy: Principles and application to simple molecules, Magnetic Resonance Spectroscopy, MRI, XRD, SEM, TEM.

Biological Inorganic Chemistry: Oxygen transport and storage-Myoglobin, Haemoglobin Bohr's effect, The chemistry of elements in medicine – chelation therapy, Cancer treatment, Antiarthritis drugs, contributions of individual elements to biological systems.

Nano-Science & Technology: Introduction, Nanotechnology applications, Material self assembly, Molecular Vs material self assembly, Self assembling materials, Two dimensial assemblies, Mesoscale self assembly (MESA), Coercing colloids, Processes of nanotechnology, Processes of Nanotechnology, Processes used in bottom up approach, Nanomaterial, Nanocrystals,/Nanoparticles, Nanostructure, Supramolecular systems, Future perspective.

Part-B

Fuels & Lubricants: Classification of fuels, Calorific values, Comparison between solid, liquid and gaseous fuels, Bomb calorimeter, Calorific value of gaseous fuel, Theoretical calculation of calorific value of a fuel, Wood, Coal, Classification of coal by rank, Selection of coal, analysis of coal, Natural Gas, Producer gas, water gas, Non-Conventional sources of energy.

Friction and wear, Lubricants, Mechanism of lubrication, classification of lubricants, lubricating oils, Greases or Semi-Solid lubricants, Solid lubricants, Synthetic lubricants, Lubricating emulsions, Properties of lubricating oils, Properties of greases, Cutting fluids, Selection of lubricants.

Water treatment: Introduction, Hardness of water, Disadvantages of hard water, Scale and Sludge formation in boilers, Caustic Embrittlement, Boiler corrosion, Priming and foaming, softening methods, Drinking water or municipal water.

Protective Coating: Introduction, Metallic coatings, Electroplating, Methods of cleaning articles before electrodeposition, Electroplating methods, Electroless plating, Some electroless platings, Some electroless platings, Some other metallic, coatings, Chemical conversion coatings, Organic Coatings, Paints, Varnishes, Enamels, Special paints.

Cement, Refractions, Glass & Ceramics, Optical Fibers: Inorganic cementing materials, Gypsum plaster, cement, Manufacture of Portland cement, Chemical composition of cement, chemical constitution of Portland cement, setting and hardening of Portland cement, heat of hydration of cement, special cements, concrete and RCC, Decay of concrete, Glasses and ceramics, Types of glasses, Optical fibers.

Composites and their Mechanical Properties: Classification of Composites, Constituents of composites.

Books Recommended:

1. Advanced Inorganic Chemistry (6th edition), F. A. Cotton and G. Wilkinson, John Wiley and Sons, 2003.
2. Inorganic Chemistry (4th edition), D. F. Shrives and P. W. Atkins, Oxford University, Oxford, 2006.
3. Modern methods of organic synthesis (3rd edition), W. Carruthers, Cambridge University Press (Cambridge Low Price editions) 1986, Reprinted 2004.
4. Reactions, Rearrangements and Reagents (4th edition), S. N. Sanyal, Bharti Bhawan (P & D), 2003.
5. Polymer Science and technology (2nd Edition), P. Ghosh, Tata McGRAW Hill, 2008.
6. Applications of Absorption Spectroscopy of Organic Compounds (4th edition), John R. Dyer, Prentice Hall of India Pvt. Ltd., 1978.
7. Introduction to Nanotechnology, C. P. Poole Jr., F. J. Owens, Wiley Interscience, 2003.
8. Nanotechnology Science, Innovation and Opportunity, L. E. Foster, Pearson Education, 2007.
9. Spectroscopic methods in organic chemistry (4th Edition), Williams & Fleming, Tata McGRAW Hill, 2003.
10. A Text Book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co, 2004.
11. Polymers: Chemistry & Physics of Modern Materials (2nd edition) J.M.G.Cowie, Blackie Academic & Professional, 1994.

12. Engineering Chemistry (16th Edition) Jain, Jain, Dhanpat Rai Publishing Company,2013.

MACI-102	Applied Mathematics-II	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To understand the theory of matrices for solving linear system of algebraic equations, eigen value problems and its application to system of ordinary differential equations.
CO 2	To attain knowledge of the concepts of partial differentiation, maxima and minima, power series expansion of function of several variables.
CO 3	To understand and apply the knowledge of double and triple integrals for evaluation of area, surface area and volume.
CO 4	To analyse the physical interpretation of gradient, divergence and curl of various scalar and vector fields.
CO 5	To understand the basics of vector integration and theorems related to line, surface and volume integrals.
CO 6	To solve linear, non-linear, homogeneous, non-homogeneous partial differential equations which arise in many branches of science and engineering.

Detailed Syllabus

Linear dependence of vectors and rank of matrices, linear transformations and inverse of matrices, reduction to normal form, bilinear form and quadratic form, consistency and solution of linear algebraic system of equations, eigen values, eigen vectors and their applications to system of ordinary differential equations, Cayley Hamilton Theorem, orthogonal, unitary, hermitian and similar matrices.

Differential calculus of functions of several variables, partial differentiation, homogeneous functions and Euler's theorem, Taylor's and Maclaurin's series, Taylor's theorem for functions of two variables, maxima and minima of functions of several variables, Lagrange's method of multipliers.

Double and triple integrals, change of order of integration, change of variables, applications to evaluation of area, surface area and volume.

Scalar and vector fields; differentiation of vectors, velocity and acceleration, vector differential operators Del, Gradient, Divergence and Curl and their physical interpretations, formulae involving these operators, line, surface and volume integrals, solenoidal and irrotational vectors, Green's theorem, Gauss divergence theorem, Stoke's theorem and their applications.

Formulation and classification of partial differential equations, solution of first order linear equations, standard forms of non-linear equations, Charpit's method, linear equations with constant coefficients, non-homogeneous linear equations, Monge's method for nonhomogeneous equations of second order; separation of variables method for solution of heat, wave and Laplace equation.

Books Recommended

1. E Kreyszig, "Advanced Engineering Mathematics". 8th Ed. John Willey, Singpore (2001) 2. R K Jain and S R K lyengar, "Advanced Engineering Mathematics", 2nd Ed. Narosa Publishing house, New Delhi (2003).
2. I A N Sneddon, "Elements of Partial Differential Equations "Tata McGraw Hill, Delhi (1974).
3. B S Grewal, "Higher Engineering Mathematics", Thirty-fifth edition, Khanna Publishers, Delhi.

ICCI-101	Basic Electrical Science	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	After completing this course the student is expected to solve and analyze various simple electrical networks (both ac and dc) using network laws and theorems.
CO 2	The student will be learning basic concepts of ac circuits and is expected to solve simple single phase and three phase ac circuits.
CO 3	He will also learn the principle and working of basic electrical measuring instruments and devices so that he can understand the behavior and performance of them.

Detailed Syllabus

Network Laws and Theorems: Network Laws for D.C. networks- Kirchhoff's laws, Node voltage and mesh current methods, Delta-Star and Star-Delta conversion, Classification of network elements, Principle of Superposition, Thevenin's and Norton's Theorems, Maximum Power Transfer Theorem.

Single Phase A.C. Circuits: Single-phase EMF generation, Effective and Average values of sinusoids and determination of form factor, Phasor diagram, Symbolic notation, phasor in polar, rectangular and exponential form. Resistive, Inductive and Capacitive circuits, A.C. series and parallel circuits. Analysis of simple RLC-series circuits, Solution of parallel circuits - resonance, Q factor.

Three Phase A.C. Circuits: Three -phase EMF generation, Delta and star connection, Line and phase quantities and relations, Solution of 3-phase circuits – balanced voltage and balanced load, Phasor diagrams, Measurement of power in three-phase circuits.

Magnetic Circuits and Transformers: Analogy between electric and magnetic circuits, Magnetic Circuits, B-H Curve, Hysteresis Loop, Solutions of simple problems, Inductances in series and parallel, Hysteresis and Eddy current losses, Transformers- constructional details, EMF equation, rating and phasor diagrams on no-load and full-load, Equivalent circuits, Regulation and efficiency, Open-circuit and short-circuit tests.

Electrical Machines: Basic principles of EMF generation, three phase Induction motors and their applications.

Electrical Instruments: Basic principles of Moving iron, PMMC, dynamometer and Induction type instruments, torque equation, Dynamometer type Wattmeter, Induction type energy meter.

Books Recommended

1. Hughes E, Smith IM, Hiley J and Brown K, "Hughes Electrical & ElectronicTechnology", 8/e, Pearson Education India
2. Del Torro, "Electrical Engineering Fundamentals", 2/e, Prentice Hall of India Pvt. Ltd.

Reference Books:

1. Kothari DP and Nagrath IJ, "Basic Electrical Engineering", Tata McGraw Hill
2. Nagsarkar TK and Suhija MS, "Basic Electrical Engineering", Oxford Univ. Press
3. Bell DA, "Electrical Circuit" 6th Edition, Prentice Hall of India Pvt. Ltd.

HMCI-102	English Communication & Report Writing	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students are equipped with effective speaking and listening skills.
CO 2	Helps to develop their soft skills, which will make the transition from college, to workplace smoother and help them to excel in their jobs.
CO 3	Enhances students' performance at Placement interviews, Group Discussions and other recruitment exercises.

Detailed Syllabus

Communication: [6 Lectures]
Meaning, Significance, Process, Verbal, Non-Verbal, Types, Formal, Informal Channels, Functions, Barriers to Communication, Miscommunication, Effective Communication Strategies, Ethical & Legal Communication, Role of Communication in Society, Technology-Enabled Communication: Tools, Positive and Negative Impact of Technology-Enabled Communication, Appropriate & Effective Technology- Based Communication.

Business Correspondence & Etiquettes: [4 Lectures]
Elements of Business Writing, Business Letters, Memorandum, Purchase Order, Quotation and Tenders, Job Application Letters, Resume Writing, Press Release, Etiquettes, Foreign Language.

Phonetics: [7 Lectures]
Organs of Speech, Mechanism of Sound Production, Different Kinds of Sounds, Consonant Sounds, Place of Articulation, Manner of Articulation, Vowels Sounds, Syllable Division and Word Stress – Rules of Stress, Intonation – Pitch, Tone Shapes, Rising Tone, Falling Tone.

Basic Applied Grammar and Usage: [6 Lectures]
Transformation of Sentences, Word Used as Different Parts of Speech, One Word Substitution, Abbreviations, Technical Terms, Foreign Expressions, Sentence: Kinds of Sentences, Simple & Complex Sentences, Interrogative, Assertive, Affirmative & Negative,

Phrases, Parts of Speech: Noun, Pronouns, Adjective, Determiners, Articles, Adverbs, Propositions, Verbs, Auxiliaries, Conjunctions, Interjections, Active & Passive Voice, Gender, Tenses, Synonyms & Antonyms, Spotting Error in Sentences, Passages, Homophones and Homonyms.

Reading & Writing Skills: [6 Lectures]
Process of Reading, Reading Purposes, Characteristic of Efficient Reading, Models, Strategies, Methodologies, Reading Comprehension, Improving Comprehension Skills, Reading Activities, Elements of Effective Writing, Writing Styles, Scientific & Technical Writing, Clarity in Writing.

Listening & Speaking Skills: [6 Lectures]
Meaning, Process & Types of Listening, Active and Passive Learning, Barriers to Listening, Effective Listening Skills, Feedback Skills, Role of Listening n an Organization. Skills of Effective Speaking and Components of Effective Talk. Discussion, Meeting and Telephone: Group Discussions, Conducting a Meeting, Telephonic Communication, Oral Presentation and Role of Audio/Visual Aids.

Report Writing: [7 Lectures]
What is a report, Difference between a Report and other forms of Writing, Kinds and Purpose of Report, Objectives of Report, Steps in writing a Routine Business Report, Basic and Subsidiary Parts of Report,
Elements of a long Formal Report, Abstract and Summary, Discussion of Findings and Analysis, Concept Development, Glossary, Appendix, Index, Process of Investigation, Research Defining and Narrowing Down the Problem, Statement of the Problem, Difference between Project Report and Technical Report.

Recommended Books

1. Rodriques. M. V., "Effective Business Communication", Concept Publishing Company New Delhi, 1992 reprint (2000)
2. Sharma. R. C., Mohan. Krishna, "Business Correspondence and Report Writing- A practical approach to business and technical communication" Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Bhattacharya. Indrajit., "An Approach to Communication Skills", Dhanpat Rai & Co.,(Pvt.) Ltd. New Delhi.
4. Wright. Chrissie, "Handbook of Practical Communication Skills", Jaico Publishing House. Mumbai.
5. Gartside. L., "Modern Business Correspondence", Pitman Publishing London.
6. Gimson. A.C., "An Introduction to the Pronunciation of English", ELBS. (YP)
7. Bansal. R. K. & Harrison. J.B., "Spoken English", Orient Longman Hyderabad.
8. Eckersley. C. E., "A Comprehensive English Grammar" Orient Longman Hyderabad.
9. Carter. Ronald and McCarthy. Michael., "Cambridge Grammar of English". Cambridge University Press, Cambridge.
10. Chaturvedi. P. D. & Chaturvedi. Mukesh., "Business Communication- Concepts, cases & applications, Pearson Publications.
11. Swan. Michael., Practical English Usage. Oxford University Press.

IPCI-101	Manufacturing Processes	Core Course	L	T	P	Credit
			2	0	0	2

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Ability to clear basic fundamental concepts of machining, welding, casting, forming and list of major metal, nonmetal, alloy and their physical characteristics.
CO 2	Selecting or suggesting suitable manufacturing processes to achieve the required products with the aim of avoiding material and time wastage.
CO 3	Recommend appropriate part manufacturing processes when provided a set of functional requirements and product development constraints.
CO 4	Developing manufacturing processes and tools for typical applications in the industries.

Detailed Syllabus

Manufacturing: Introduction to manufacturing processes, Basic terminology used Economical and technological considerations.

Materials properties and their application: Different engineering materials, Properties, Nomenclature, Basics of heat treatment.

Carpentry: Introduction, Classification of wood, Seasoning of wood, Classification of carpentry tools, Joints and joining processes, Wood working machines and processes, safety precaution.

Fitting: Introduction, Tools used in fitting, measuring and marking tools, the process of making sawing, Filling, Tapping and die, Introduction to drills.

Welding: Introduction, Various welding processes with brief introduction, Electric Arc welding, Arc welding procedure, List of equipment for electric arc welding, Gas welding process and equipment, Soldering and Brazing process.

Smithy: Introduction, Types of forging, Equipment used in the smithy shop, Smithy tools, Black smith's hearth, Hand forging operations.

Foundry: Introduction, Basic terminology, Pattern, Types of patterns, Patterns allowances, Tools for hand Moulding, Moulding sand and Moulding process, Crucible furnace, Operation of cupola, Foundry containers, Casting defects, Safety precautions.

Sheet metal working: Introduction, Types of sheets (ferrous/non-ferrous), Standard sheet sizes and their measurement, Tools used in sheet metal.

Metal cutting: Introduction, Classification of machine tools and cutting tolls, Basic operations on lathe, Drilling, Shaper, Milling, Cutting tool material, Work-holding devices, Cutting parameters i.e. speed, feed and depth of cut.

Books Recommended

1. Schey A J, "Introduction to Manufacturing Processes", McGraw Hill Book Company, New York (1987).
2. Sharma P C, "Production Technology", S Chand & Co, (2003)
3. DeGarmo E Paul, "Materials & Processes in Manufacturing", Wiley, 9th Edition.
4. Parmar R S, "Welding Processes & Technology", Dhanpat Rai Publishers.
5. Juneja B L, "Fundamentals of Metal Cutting & Machine Tools", New Age International (1998)

HMCI-103	English Communication Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students are equipped with effective speaking and listening skills.
CO 2	Helps to develop their soft skills, which will make the transition from college, to workplace smoother and help them to excel in their jobs.
CO 3	Enhances students' performance at Placement interviews, Group Discussions and other recruitment exercises.

Detailed Syllabus

Business Letters:

Structure of Business Letters, Language in Business Letters, Letters of Enquiry & Their Places, Sales Letters, Memorandum, Quotations, Tenders, Bank Correspondence, Applications and Appointment Letters, Resume, Bio data, Curriculum Vitae.
[6 lectures]

Comprehension and Precis Writing:

Role of Listening, Ear Training, Reading and Comprehension: Reasons for Poor Comprehension. Improving Comprehension Skills, Developing Skills of Comprehension. Difference Between Precis Writing and Comprehension, Techniques of Precis Writing, Topic Sentences and its Arrangement. [4 lectures]

Essay Writing:

Definition of Essay, Types of Essay, Essay writing for Engineers/Professionals, Use of Essay Writing, Dimensions of Essay Writing: Literary, Scientific, Sociological, Contemporary, Problem Solving Essays, Horizons of Essay Writing: Narrative Essays, Descriptive Essays, Reflective Essays, Expository Essays, Argumentative and Imaginative Essays. [4 lectures]

Introduction to Phonetics:

Organs of Speech, Mechanism of Sound Production, Different Kinds of Sounds, Consonant Sounds, Place of Articulation, Manner of Articulation, Vowels Sounds, Syllable Division and Word Stress- Rules of Stress, Intonation- Pitch, Tone Shapes, Rising Tone, Falling Tone.

[6 lectures]

Role Play and Giving Direction:

Voice Characteristics, Pitch and Modulation, Pace and Non-Verbal Communication, Personality and Attitude. Ways of Giving Direction- Written and Oral, Listening Skills, Describing Objects, Situations and People- Important features, Describing a Process, Person, Object, Vocabulary. [6 lectures]

Oral Presentations: Presentation Skills, Attention Gaining Devices, Barriers to Effective Presentation [6 lectures]

Telephonic Skills: Rules for Calling and Receiving a Call, Skills for Telephone Interview, Basic Telephone Etiquette. [2 lectures]

Group Discussion and Debate: Features of a Debate, Analytical Skills, Types of Debates, Non-verbal Communication. [8 lectures]

Project work/ Term Paper: Students will be required to Produce and Submit a Project Work/Term Paper on a Topic by the End of the Semester. The Topic should Involve Data Collection, Analysis, and Reporting.

Books Recommended

1. Rodriques. M. V., "Effective Business Communication", Concept Publishing Company New Delhi, 1992 reprint (2000)
2. Sharma. R. C., Mohan. Krishna, "Business Correspondence and Report Writing- A practical approach to business and technical communication" Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Bhattacharya. Indrajit., "An Approach to Communication Skills", Dhanpat Rai & Co., (Pvt.) Ltd. New Delhi.
4. Wright. Chrissie, "Handbook of Practical Communication Skills", Jaico Publishing House. Mumbai.
5. Gartside. L., "Modern Business Correspondence", Pitman Publishing London.
6. Gimson. A.C., "An Introduction to the Pronunciation of English", ELBS. (YP)
7. Bansal. R. K. & Harrison. J.B., "Spoken English", Orient Longman Hyderabad.
8. Eckersley. C. E., "A Comprehensive English Grammar" Orient Longman Hyderabad.
9. Carter. Ronald and McCarthy. Michael., "Cambridge Grammar of English". Cambridge University Press, Cambridge.
10. Chaturvedi. P. D. & Chaturvedi. Mukesh., "Business Communication- Concepts, cases & applications, Pearson Publications.
11. Swan. Michael., Practical English Usage. Oxford University Press.

CYCI-103	Applied Chemistry-A Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To understand the mechanism of synthesis of polymers and their applications.
CO 2	To understand the concept of water purification through ion exchange, COD etc techniques.
CO 3	To study the partition coefficient and distribution of solute in different solvents.

CO 4	To study the synthesis of drugs like aspirin.
CO 5	To understand the concept of acid-base titrations using pH and conductance measurements.
CO 6	To analyze the solutions and extraction of metals using spectrophotometric techniques.
CO 7	To learn other techniques like thin layer chromatography, determination of molecular weight, and adsorption phenomenon.
CO 8	To find viscosity of different solvents and their applications.

List of Experiments

1. Preparation of Urea-formaldehyde resins.
2. Determine the viscosity of test liquids with the help of Ostwald viscometer.
3. Find out the Rf value of the given amino acid by thin layer chromatography (TLC) and identify the amino acid present in a given mixture by TLC
4. Isolation of caffeine from Tea leaves.
5. To determine the molecular weight of an organic compound by depression in freezing point (Rast Camphor method).
6. Find out the ion–exchange capacity of a cation exchanger (Dowex -50).
7. To prepare phenol formaldehyde resin (Bakelite).
8. To determine the ion-exchange capacity of a given anion exchange resin.
9. To synthesize Paracetamol and determine the percentage yield of the product.
10. Determine the equivalent weight of a given acid.
11. Determination of total (temporary and permanent) hardness in water sample using EDTA as standard solution (Complexometric Titration).
12. Separation of Metal ions by paper chromatography.
13. To estimate the nickel content in the given sample using dimethyl glyoxime.
14. To determine the strength of given acid using pH titrations.
15. To determine the strength of given acid using conductometric titrations.
16. To determine the average molecular weight of a polymer.
17. Determine the surface concentration of 1-butanol in aqueous solution.
18. Determine the amount of sodium carbonate and sodium hydroxide in a mixture by titration.
19. Determination of ferrous ions using potassium dichromate by internal indicator.
20. To Purify Common organic solvents by distillation.
21. To Determine the Acid Value of Fat.
22. To prepare the pure sample of phthalimide.
23. Isolation of Casein Protein from Milk.
24. Synthesis of cis- and trans- potassiumdioxalatodiaquochromate (III)
25. Preparation of a conducting polymer.
26. To determine concentration of trace metals by atomic absorption spectrophotometer.

Note: At least 10-12 experiments will be carried out.

CYCI-104	Environmental Studies	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students could understand the mechanism of various environmental issues and due to this a new idea for remedy of environmental problems may be solved. The students could also understand responsibility towards environmental and spread this to others for perform our duties to environment.
CO 2	Students ethical values could be enhance.
CO 3	Students are updated about various energy resources (renewable and non-renewable) from this they could understand the importance of energy conservation and consumption.

Detailed Syllabus

Unit 1: Multidisciplinary nature of environmental studies
Definition, scope and importance, Need for public awareness. (2 lectures)

Unit 2: Natural Resources:
Renewable and non-renewable resources: Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles. (8 lectures)

Unit 3: Ecosystems

- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following ecosystem: -

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(6 lectures)

Unit 4: Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Biogeographical classification of India

- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, National and local levels. • India as a mega-diversity nation
- Hot-sports of biodiversity.
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

(8 lectures)

Unit 5: Environmental Pollution

Definition

• Cause, effects and control measures of: -

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

• Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
• Role of an individual in prevention of pollution.
• Pollution case studies.
• Disaster management: floods, earthquake, cyclone and landslides

(8 lectures)

Unit 6: Social Issues and the Environment

• From Unsustainable to Sustainable development
• Urban problems related to energy
• Water conservation, rain water harvesting, watershed management
• Resettlement and rehabilitation of people; its problems and concerns. Case Studies
• Environmental ethics: Issues and possible solutions.
• Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.
• Wasteland reclamation.
• Consumerism and waste products.
• Environment Protection Act.
• Air (Prevention and Control of Pollution) Act.
• Water (Prevention and control of Pollution) Act
• Wildlife Protection Act
• Forest Conservation Act
• Issues involved in enforcement of environmental legislation.
• Public awareness. (7 lectures)

Unit 7: Human Population and the Environment

• Population growth, variation among nations.
• Population explosion – Family Welfare Programme.
• Environment and human health.
• Human Rights.
• Value Education.
• HIV/AIDS.

- Women and Child Welfare.
- Role of Information Technology in Environment and human health.
- Case Studies (6 lectures)

Unit 8: Field work

- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

(Field work Equal to 5 lecture hours)

Books Recommended:

1. Environmental Studies, Benny Joseph, 3rd Addition, McGraw Hill Education (India) Private Limited, 2018.
2. Environmental Studies, Deeksha Dave, S.S. Katewa, Cengage Learning India Pvt. Ltd., 2012.
3. Environmental Chemistry, 7th Addition, A.K. DE, New Age International (P) Limited,2010.
4. Environmental Science, Anubha Kaushik, C.P. Kaushik, New Age International (P) Limited, 2011.
5. Environmental Studies,Reach Bharucha, 2004.

MEPC-201	Strength of Materials	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: Elements of Mechanical Engineering (MEX-102).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To establish an understanding of the fundamental concepts of mechanics of deformable solids.
CO 2	To provide students with exposure to the systematic methods for solving engineering problems in solid mechanics.
CO 3	To understand the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear and combined loading.
CO 4	To build necessary theoretical background for further structural analysis and design course.

Detailed Syllabus

Simple stresses and strains: Concept of stress and strain: St. Venants principle of stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stresses and strains in bars subjected to axial loading, Modulus of elasticity, stress produced in compound bars subjected to axial loading, Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound walls.

Compound stresses and strains: Two dimensional system, stress at a point on a plane,

principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and theirapplications, Two dimensional stress-strain system, principal strains and principal axis of strain,circle of strain and ellipse of strain, Relationship between elastic constants.

Bending moment and shear force diagrams: Bending moment and shear force diagrams, SFand BM definitions. BM and SF diagrams for cantilevers, simply supported and fixed beams withor without overhangs and calculation of maximum BM and SF and the point of contraflexureunder Concentrated loads, Uniformity distributed loads over the whole span or part of span,combination of concentrated loads (two or three) and uniformly distributed loads, uniformlyvarying loads, application of moments.

Theory of bending stresses: Assumptions in the simple bending theory, derivation of formula: its application to beams of rectangular, circular and channel sections, composite/fletched beams, bending and shear stresses in composite beams. Unsymmetrical Bending, Combined bending and torsion, bending and axial loads etc.

Slope and deflection: Relationship between moment, slope and deflection, Moment area method, Macualay's method, Use of all these methods to calculate slope and deflection for the determinant beams.

Torsion: Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion, analysis of close-coiled-helical springs.

Thin cylinders and spheres: Derivation of formulae and calculations of hoop stress longitudinal stress in a cylinder, and sphere subjected to internal pressures increase in Diameter and volume.

Columns and struts: Columns under uni-axial load, Buckling of Columns, Slenderness ratio and conditions. Derivations of Euler's formula for elastic buckling load, equivalent length,Rankine Gordon's empirical formula.

Books Recommended

1. Pytel A H and Singer F L, *"Strength of Materials",* 4th Edition, Harper Collins, New Delhi(1987).
2. Beer P F and Johnston (Jr) E R, *"Mechanics of Materials",* SI Version, Tata McGraw Hill,India (2001).
3. Popov E P, *"Engineering Mechanics of Solids",* SI Version 2nd Edition, Prentice Hall ofIndia, New Delhi (2003).
4. Timoshenko S P and Young D H, *"Elements of Strength of Materials",* 5th Edition, EastWest Press, New Delhi (1984).
5. Jindal U C, *"Introduction to Strength of Materials",* 3rd Edition, Galgotia Publishing PrivateLimited New Delhi (2001).

MEPC-203	Theory of Machines	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

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

CO 1	Understand the concepts of machines, mechanisms and related terminologies.
CO 2	Analyze planar mechanism for displacement, velocity and acceleration graphically.
CO 3	Analyze various motion transmission elements like gears, gear trains, cams, belt drives and rope drives.
CO 4	Utilize analytical, mathematical and graphical aspects of kinematics of machines for effective design.
CO 5	Perform the kinematic analysis of a given mechanism.

Detailed Syllabus

Basic Concepts: Kinematics of machine, Kinematic link and their different types, types ofkinematic pair, kinematic chain, mechanism and inversions of four bar chain and slider crankmechanism. Degree of freedom, synthesis of linkages – number synthesis, Grashof's riterionand introduction to dimensional synthesis.

Velocity Analysis: Motion of a link, velocity of a point on a link by relative velocity method, velocities of slider crank mechanisms, rubbing velocity at a pin joint, velocity of a point on a link by instantaneous center method, properties and types of I-Center, Kennedy theorem andmethods of locating I-centers in a mechanism.

Acceleration Analysis: Acceleration of a point on a link, acceleration in slider crankmechanism, Coriolis component of acceleration, Quick-return mechanism.

Cams and Follower: Types of cams and followers, cam terminology, types of motion of thefollower, analysis of motion of the follower, analysis of motion of the follower for cams withspecified contours.

Gears: Classification of gears, terminology used in gears, law of gearing, velocity of sliding,forms of teeth, construction and properties of an involute, construction and properties ofcycloidal teeth, effect of variation of center distance on the velocity ratio of involute profile tooth gears, length of path of contact, arc of contact, number of pairs of teeth in contact, interference, minimum number of teeth, interference between rack and pinion, undercutting, terminology of helical and worm gears.

Gear Trains: Definition of simple, compound, reverted and epicyclic gear trains, velocity ratio of epicyclic gear trains.

Belt, Rope and Chain Drive: Types of belt drives, velocity ratio, law of belting, length of belt, ratio of friction tensions, power transmitted, effect of centrifugal tension on power transmission, condition for maximum power transmission, concept of slip and creep. Chain drive, chain length and angular speed ratio.
Governors: Different types of centrifugal and inertia governors: hunting, isochronism, stability, effort and power of governor, controlling force.
Note: In addition to the tutorials several studies related to mechanism, mechanism trains

(Lathe, Milling Machines, Shaper), automobiles mechanisms, automobile gearbox, differential mechanisms will be performed by the students. Characteristics of governors, cam and cam profile experiments will be demonstrated during the tutorial classes.

Books Recommended

1. Bevan T, "*The Theory of Machines",* 3rd Edition CBS Publishers and Distributors (2002).
2. Shigley J E and Vickar J J, *"Theory of Machines and Mechanism"*, 2nd Edition, McGrawHill, New Delhi (1995).
3. Wilson C and Sadler J, *"Kinematics and Dynamics of Machine"*, 3rd Edition, Prentice Hall(2002).
4. Ratan S S, *"Theory of Machines",* 1st Edition, Tata McGraw Hill, New Delhi (1993).
5. Rao J S and Dukkipati R V, *"Mechanism and Machine Theory",* 2nd Edition, New AgeInternational (P) Limited, Delhi (1992).

MEPC-205	Machine Drawing	Core Course	L	T	P	Credit
			1	0	6	4

Pre-requisites: Engineering Graphics (MEX-101)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Recognize to use modern engineering tools, software and equipment to analyse different drawings for Design & manufacturing.
CO 2	Identify the elements of a detail drawing and prepare Engineering Drawing using orthographic projections and sectional views.
CO 3	Recognition of the need and an ability to engage in self-education and life-long learning.
CO 4	An Ability to understand and apply the knowledge of machine drawing as a system of Communication in which ideas are expressed clearly and all information fully conveyed.

Detailed Syllabus

Review of Principle of Orthographic Projections, fits and tolerances, machining symbols, sectioning and conventional representation, dimensioning, welding symbols, various types of screw threads, screw fasteners.

Assembly and Disassembly:
Coupling, Pin type, flexible coupling, and cone friction clutch.Pipe and Pipe fittings.

Boiler Mountings: steam stop valve, feed check valve safety valve, blow off cock valve.

Bearings: Swivel bearing, thrust bearing, Plummer block.

Machine Tool Parts: Lathe tail stock, tool post.

Miscellaneous: Screw jack, drill press vice, connecting rod, eccentric.

Introduction to Computer Aided Drafting: Students may be given some drawing problems

involving the application of available CAD softwares.
Note: First angle projection to be used. BIS codes for various applications in Machine Drawing. Drawings should contain bill of materials and illustrate the use of its tolerances and surface finish requirements. The syllabus given above indicates the broad outlines and the scope of the subject to be covered.
Based on the syllabus a number of sheets will be prepared by the students in practical classes as listed below:
Sheet No.1: Types of lines, Conventional Representation for materials.
Assignment No.1: Sectioning Practice on sketch book.
Sheet No. 2: Various types of machine components for sectioning.
Assignment No.2: Tolerances, Limits and Fits, Practice on Sketchbook.
Assignment No.3: Machining Symbols – Surface Texture and its importance.
Assignment No.4: Screw threads practice on sketchbook.
Sheet No. 3: Various Types of Nuts, Bolts, Studs and Setscrews & Foundation Bolts
Assignment No. 5: Coupling, its types and applications.
Sheet No. 4: Pin type flexible coupling and cone friction clutch.
Sheet No. 5: Assembly of various pipe joints and fittings.
Sheet No. 6: Assembly and part drawing of Screw Jack.
Sheet No. 7: Assembly of Drill press vice.
Sheet No. 8: Assembly and part drawing of Steam stop valve.
Sheet No. 9: Assembly of safety valve.
Sheet No. 10: Assembly of Blow of cock.
Sheet No. 11: Assembly and part drawing of Tail Stock.
Sheet No. 12: Assembly of Thrust bearing and Plummer block.
Assignment No. 6: Sketch of Swivel bearing on the sketch book.
Sheet No. 13: Assembly and part drawing of connecting Rod and eccentric.

Books Recommended

1. Gill P S, *"Machine Drawing",* 17th Edition, S K Kataria and Sons, New Delhi (2002).
2. Bhatt N D, *"Machine Drawing",* 26th Edition, Charotar Publishing House, Anand (1991).
3. Sidheshwar N, Kannaiah P and Sastry V V S, *"Machine Drawing",* 27th Reprint, TataMcGraw Hill, New Delhi (2003).
4. Luzadder W J, *"Fundamentals of Engineering Drawing",* PHI, New Delhi, 9th Edition(1988).
5. Bertoline G R, Wiebe E N., Miller C L, and Mohler J L, *"Technical GraphicsCommunication",* 2nd Edition, IRWIN McGraw Hill, New York (1997).

MEPC-207	Applied Thermodynamics-I	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understanding of properties of the steam, Rankine cycle, reheating, regeneration, Binary vapour cycle.

CO 2	Working of different types of boilers, Mountings and accessories boiler draught and its calculations, Boiler performance.
CO 3	Flow the steam through the different types of nozzles, Nozzle efficiency, steam injector.
CO 4	Working of different types of steam turbines, Analysis of performance of turbines, governing of turbines.
CO 5	Working of different types of steam condensers, calculation of cooling loads.
CO 6	Study of reciprocating compressors, Analysis of the work done, isothermal efficiency, etc.

Detailed Syllabus

Fundamentals: Pure substances, Thermodynamic property relations, Properties of mixtures, Fuel and Combustion.

Steam Generators: Review of steam generation process. Classification, Fire and water tube boilers, Description of Cochran, Locomotive, Lancashire Babcock and Wilcox boilers and Sterling Boiler, mountings and accessories: Economizer, super heater etc. Modern high pressure boilers, Characteristi
cs of high pressure boilers, Advantages of forced circulation, steam accumulators, boiler performance, equivalent evaporation, boiler efficiency, Boiler Trial.

Working Cycles: Simple Rankine cycle, methods of improving efficiency: Feed water heating (Bleeding), reheat cycle, combined reheat and regenerative cycle, Ideal working fluid – Binary vapour cycle, combined power and heating cycles. Introduction to Steam Engine with brief discussion.

Nozzle: Types of nozzles and their utility, Flow of steam through nozzles, Critical pressure and discharge, Area of throat and exit for maximum discharge, Effect of friction on Nozzle efficiency, Supersaturated flow.

Steam Turbines: Classification; Impulse & Reaction Steam turbines, description of components, Pressure and velocity compounding, Velocity diagram and work done, Effect ofblade friction on velocity diagram, Stage efficiency and overall efficiency, Reheat factor and condition curve. Degree of reaction, blade efficiency and its derivation; calculation of blade height, backpressure and extraction turbines and cogeneration; Economic assessment. Method of attachment of blades to turbine rotor, losses in steam turbines, Governing of steamturbines, Labyrinth packing.

Condensers: Function, Elements of condensing plant, types of condensers, Dalton's law of partial pressure applied to condenser problems, condenser and vacuum efficiencies. Cooling water calculations.Effect of air leakage, Methods to check and prevent air infiltration.Description of air pump and calculation of its capacity.

Reciprocating Air Compressors: Use of compressed air in industry.Classification of air compressors, Operation of single stage reciprocating compressors, Work input and the best value of index of compression.Isothermal and polytropic efficiency. Effect of clearance and volumetric efficiency, Multistage compression and its advantages. Optimal multistaging, work input in multistage compression, Reciprocating air motors.

Books Recommended

1. Yunus Cengel& John Cimbala," Fluid Mechanics: Fundamentals and Applications", 2nd reprint 2007, Tata McGraw Hill, New Delhi.
2. F M White, "Fluid Mechanics", 6th ed., McGraw Hill, New York.

MEPC-209	Material Science and Metallurgy	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To apply knowledge of mathematics, science & engineering.
CO 2	To apply and integrate knowledge of structure and properties processing and performance to solve materials selection problems.
CO 3	To analyse and learn the behaviour of different material under the testing of Hardness, Impact, Creep, Fatigue, Torsion and fracture test.
CO 4	Ability to learn the various defects and imperfections in crystals of material, diffusion among metals, various phase transformations of Fe w.r.t change in carbon composition and fundamental mechanism of chemical and heat treatment like normalizing, tempering, hardening, carburizing, nitriding and cyaniding etc.

Detailed Syllabus

Structure of Crystalline Solids: Crystal structure and crystal systems, closed packing, some prominent crystal structures, Miller indices, determination of crystal structure, reciprocal lattice.

Imperfections in Solid: Points imperfections and their equilibrium concentration, edge and screw dislocations, Burgers vector and the dislocation loop, stress field and energy of dislocation, Dislocation multiplication.

Strengthening Mechanisms: Grain Boundaries and deformation, strengthening from grain boundaries, Yield Point Phenomenon, Strain Ageing, Solid Solution strengthening, strengthening from fine particles, fiber strengthening, strengthening due to point defects, Martensite strengthening etc.

Fracture: Types of Fracture, Griffith Theory, Metallographic aspects of fracture, Fractography, Ductile Fracture, Notch Effects, Ductile to Brittle Transition.

Mechanical Testing: Tension test, Hardness tests, Torsion test, Impact Test, Creep & Fatigue Testing.

Iron Carbon Diagram: Allotropic forms of carbon, solid and liquid state reactions, types of steels, types of cast irons, microstructures at various carbon percentages, properties as a function of microstructures, significance of IC diagram. Cooling curves and equilibrium diagrams for brass and aluminum alloys.

TTT Diagrams: Time temperature transformations diagram, transformations as a function of cooling rate, mechanism of various transformations, and significance of TTT diagram.

Heat Treatment Methods: Mechanism of annealing and advantages, mechanism of normalizing and advantages, mechanisms of tempering and advantages, mechanism of hardening and advantages, mechanism of case hardening and advantages, mechanism of induction hardening and advantages.

Chemical Heat Treatment Methods: Introduction to chemical heat treatment, mechanism and methods of carburizing, nitriding, cyaniding, introduction to flame hardening.

Hardenability: Meaning of hardenability, tests of hardenability, factors affecting hardenability

Effect of Alloying Elements: Effect on strength and hardness, effect on hardenability, effect on transformation temperature.

Books Recommended

1. Lakhtin Yu, "*Engineering Physical Metallurgy & Heat Treatment*", Mir Publishers (1990).
2. Dieter E G, *"Mechanical Metallurgy*", McGraw Hill Book Company (1988).
3. Shackelford F J, Murlidhara K M, "*Introduction to Materials Science for Engineers*", Pearson Education (2007).
4. Askerland RD, Phule P, "The *Science & Engineering of Materials*", Thomson Education(2006).
5. Van Vlack L.H, *"Elements of Material Science and Engineering",* Addison Wasley Publishers (1989).
6. Smith W F, *"Principles of Material Science and Engineering",* McGraw Hill, New York(1993).

MEPC-211	Fluid Mechanics-I	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To make the student understand the utility of studying the course of Fluid Mechanics in understanding the physical phenomenon involving fluids either at rest or in motion.
CO 2	To enable the students understand the theoretical aspect of solving different physical problems involving fluids at rest or in motion.
CO 3	To discuss with the students different modeling techniques for writing the mathematics (e.g., differential and integral formulations) for fluid mechanics problems.
CO 4	To make students understand about the different techniques used for analyzing the theoretical, flow visualization and experimental solutions of problems pertaining to fluid mechanics.
CO 5	To make students understand key contributions by various scientists for development of theoretical understanding of major issues related to fluid mechanics physics.

CO 6	To discuss with the students some bench mark analytical solutions available for fluid mechanics and problems and general procedure for solving theoretical models equations and limitations of analytical solution techniques.

Detailed Syllabus

Introduction

The Concept of a Fluid, The Fluid as a Continuum, Dimensions and Units, Physical Properties of the fluids, Velocity Field, Thermodynamic Properties of a Fluid, Viscosity and other Secondary Properties, History and Scope of Fluid Mechanics Basic Physical Laws of Fluid Mechanics, Uncertainty of Experimental Data, Basic Flow-Analysis Techniques; Problem-Solving Techniques, the Engineering Equation Solver.

Fluid Statics

Hydrostatic Pressure Distributions, Application to Manometry, Hydrostatic Forces on Plane Surfaces, Hydrostatic Forces on Curved Surfaces, Hydrostatic Forces in Layered Fluids, Buoyancy and Stability, Meta- centre and Meta-centric height, Pressure Distribution in Rigid-Body Motion

Fluid Kinematics

The Acceleration Field of a Fluid, the Differential Equation of Mass Conservation, The Differential Equation of Linear Momentum, The Differential Equation of Angular Momentum, The Differential Equation of Energy, Boundary Conditions for the Basic Equations, the Reynolds Transport Theorem, Formulation of equations for Conservation of Mass, Linear Momentum, Angular-Momentum and Steady Flow Energy Equation (SFEE) from the Theorem, Frictionless Flow: The Bernoulli Equation, The Stream Function, Vorticity and Irrotationality, Frictionless Irrotational Flows. Flow Patterns: Streamlines, Streaklines, Pathlines and Timelines.

Dimensional Analysis and Similarity: Dimension, Units, dimension reasoning, dimensional quantities, construction of relationship by dimensional analysis using the indicial methods, dimensional analysis by group methods, significant of dimensionless numbers, Geometric similarity, Dynamic similarity, similarity applied to rotodynamic machines.

Viscous Flow: Navier-Stokes equation of motion, relationship between shear stress and pressure gradient, two-dimensional laminar flow between two fixed parallel planes and pipe flow, plain Couette flow and its application to hydro-dynamic theory of lubrication, Flow in Noncircular Ducts, Minor Losses in Pipe Systems, Multiple-Pipe Systems, Experimental Duct Flows: Diffuser Performance, Fluid Meters.

Turbulence and Turbulent through pipes: Understanding of Physics of Turbulence, Growth of instability and transition from laminar to turbulent flow, turbulent velocity profile for flow through pipes, Flow losses in pipes, Darcy equation for head loss due to friction.

Flow Around Immersed Bodies: Concept of friction, pressure, wave and induced drag- lift and drag coefficients; variation of drag coefficient with Reynolds number for two dimensional bodies (flat plate, circular cylinder); Vortex shedding from cylindrical bodies, effect of streamlining; drag coefficient versus Reynolds number for flow past axisymmetric bodies (sphere); Terminal velocity, lift of an airfoil, airfoil of finite length-effect on drag and lift, downwash and induced drag.

Books Recommended

1. Çengel, Y.A. and J.M. Cimbala, *Fluid Mechanics*, McGraw-Hill, Boston, MA.
2. Munson, B.R., D.F. Young, and T.H. Okiishi, *Fundamentals of Fluid Mechanics*, 4th Ed., Wiley, New York, NY, 2002.
3. White, F. M., *Fluid Mechanics*, Fifth Edition, McGraw Hill 2003.
4. Kundu, P. K., and Ira M. Cohen, *Fluid Mechanics*, 4th ed., Academic Press, 2007/Elsevier, 2008. ISBN-10: 0123737354, ISBN-13: 978-0123737359.
5. White, F. M., *Viscous Fluid Flow*, 2nd Edition, McGraw Hill 1991.
6. Currie, I.G., *Fundamental Mechanics of Fluids*, 2nd Edition, McGraw Hill 1993.
7. Panton, R.L., *Incompressible Flow*, 2nd Ed., John Wiley & Sons, 1996.
8. Fay, J. A., *Introduction to Fluid Mechanics*, Cambridge, MA: MIT Press, 1994. ISBN: 0262061651
9. Chevray, R. and J. Mathieu, *Topics in Fluid Mechanics*, Cambridge University Press, 1993.

MEPC-213	Strength of Material and Material Characterization Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO 1	Performing basic characterization of mechanical and morphological properties of materials.
CO 2	Tests for the investigation of the nature, microstructure of materials, grain structure by using metallurgical microscope of different material under different heat treatment conditions.
CO 3	An integrated understanding of the scientific and engineering principles of Metallurgical and Materials Engineering.
CO 4	To analyse the experimental data and interpretation of the results with relation to the properties of the investigated materials under different testing conditions like tensile, compression, bending, Impact etc.

List of Experiments

1. Determination of Young's modulus, tensile, strength and percentage elongation for steel, aluminum, brass and cast iron specimens on universal testing machine. Also plot the stress strain diagram.
2. To perform the compression test for cast iron specimen on universal testing machine.
3. To determine the deflection for mild steel specimen and verify the beam formula for specimen in bending.
4. To determine the stiffness of the following:
   (i) Cantilever beam (ii) Spring under compressive and tensile loading.
5. To measure the total energy absorbed in fracturing of the ductile specimen on Charpy and Izod setup, Cryogenic temperature testing and demonstration of Ductile to Brittle Transition temperature.
6. To plot and study the S-N curve for steel, aluminum and fibre reinforced composite material at 25%, 50%, 60% and 75% of ultimate tensile strength of the specimen.

7. Preparation of specimen for hardness test & testing of prepared specimens for Brinell hardness, Rockwell hardness & Vickers Hardness.
8. To study the behaviour of steel and aluminum specimen under torsion.
9. Analyzing the microstructure of steel and cast iron using Metallurgical Microscope.
10. Determining the grain size of the given specimen using Metallurgical Microscope.
11. Hardening of ferrous specimen by quenching in oil bath &Analyzing the microstructure using Metallurgical Microscope.
12. Annealing of ferrous specimen by slow cooling in the furnace &Analyzing the microstructure using Metallurgical Microscope.

MEPC-215	Theory of Machines Lab*	Core Course	L	T	P	Credit
			0	0	2	1

CO 1	Ability to demonstrate the principles of kinematics and dynamics of machinery
CO 2	Ability to use the measuring devices for dynamic testing

List of Experiments

1. Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
2. Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
3. Determination of Mass moment of inertia of Fly wheel and Axle system.
4. Study of gyroscopic effect and couple in motorized gyroscope.
5. Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cam profile drawing, Motion curves and study of jump phenomenon

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

MEPC-202	Applied Thermodynamics-II	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: Applied Thermodynamics-I (MEPC-207)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Apply mass, momentum, energy and entropy balances to compressible flow and use compressible flow tables and relations to solve problems involving compressible flow in a nozzle and diffuser.
CO 2	Apply the principles of thermodynamics to evaluate the performance of Rotary, Centrifugal and Axial Air compressors,
CO 3	Design the bladeing, study the velocity triangles and estimate the performance of centrifugal and axial flow compressors.
CO 4	Understand the ideal and real thermodynamic cycles of air-breathing engines and Industrial gas turbines Gas Turbines incorporating intercooling, reheat, regeneration, afterburning, etc.

Detailed Syllabus

Introduction: Stagnation properties, sonic velocity and Mach number, Mach waves, Flow through Nozzles and diffusers,Metastable state and super saturated flow, thrust function. Flow through variable area, isentropic flow, adiabatic flow with friction; Flow through constant area with friction (Fanno Flow), Frictionless Flow through a constant area duct with heat transfer (Rayleigh Flow), Isothermal flow through a constant area duct, normal shock waves, Rankine Hugoniot equation, Strength of shock waves, application of gamma function to specific flow process.

Rotary Compressors: Classification of rotary compressors, comparison with reciprocating compressors, working of rotary compressors like Roots blower, Lysholm Compressor and Vanetype Blower. Determination of total work done for compressors, energy loss in internal friction.Isentropic, polytropic and isothermal efficiencies of compressor.

Centrifugal Compressors: Thermodynamic analysis of centrifugal compressor: Stage, polytropic, isentropic and isothermal efficiencies, velocity vector diagrams for centrifugal compressors, power calculation, pre-guided vanes,pre-whirl, Slip factor, power input factor. Modes of energy transfer in impeller and diffuser. Degree of reaction and its derivation, energy transfer in backward, forward and radial vanes, Derivation of Non-dimensional parameters for plotting compressor characteristics, surging and choking in centrifugal compressors.Various losses occurring in centrifugal compressors and application of centrifugal compressors.

Axial Flow Compressor: Components of axial flow compressor, aerofoil blading, angle of attack, coefficients of lift and drag, turbine versus compressor blades, velocity vector diagrams, thermodynamic analysis and power calculations. Modes of energy transfer in rotor and stator blade flow passages. Work done factor, Degree of reaction and Blade efficiency, isentropic polytropic and Isothermal Efficiencies. Surging, choking and stalling in axial flow compressors, characteristic curves for axial flow compressor, flow parameters of axial flow compressor pressure coefficient, flow coefficient, work coefficient and temperature rise coefficient, specific speed etc. Comparison of axial flow compressor with centrifugal compressor and reaction turbine.Application of axial flow compressors.

Gas Turbines: Classification, Open and closed cycle and their comparison. Application of gas turbine.Position of gas turbine in power industry.Thermodynamic analysis-Brayton cycle, calculation of net output, work ratio, and thermal efficiency, Operating variables and their effects on thermal efficiency and work ratio.Gas turbine cycle with regeneration, intercooling, multistage compression and expansion. Closed and semi closed gas turbine cycle, requirements of a gas turbine combustion chamber, types of combustion chambers, Pressure losses in heat exchangers and combustion chambers. Gas turbine fuels.

Jet Propulsion: Principle of jet propulsion, Performance characteristics of different propulsion systems, Application of various propulsion systems.

Books Recommended

1. Shepherd D G, *"An Introduction to Gas Turbine",* Von Nastrand, New York (1949).
2. Stodola A, *"Steam and Gas Turbines"*, McGraw Hill Book Company, (1970).

3. Shapiro A M, *"Dynamics and Thermodynamics of Compressible Fluids"*, Ronald's Press, New York (1953).
4. Benson R W, *"Advanced Engineering Thermodynamics"*, Pergamon Press, London (1975).
5. Cohen H, Rogers G F C and Saravanamuttoo H I H, *"Gas Turbine Theory"*, Orient Longman Limited, New Delhi (1996).

MEPC-204	Dynamics of Machines	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: Theory of Machines (MEPC-203).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Able to do static and dynamic force analysis on different mechanism.
CO 2	Able to demonstrate the torque analysis on any kind of fly wheel i.e., either on engine fly wheel or machine fly wheel.
CO 3	Understand and avoid/suppress certain common dynamical problems a machinery may undergo.
CO 4	Understand the fundamentals of machine design for desired kinematic or dynamic performance.
CO 5	Understand the fundamentals of mechanical vibrations.

Detailed Syllabus

Brakes and Dynamometers: Types of brakes, principle and function of various types of brakes, problems to determine braking capacity, different types of dynamometers.

Static Force Analysis: Static equilibrium, equilibrium of two-force and three-force members, members with two forces and a torque, free body diagram, principle of virtual work, friction in mechanisms.

Dynamic Force Analysis: D' Alembert Principle, dynamic analysis of four-link mechanisms and slider-crank mechanisms, analytical and graphical method, velocity and acceleration of piston, angular velocity and angular acceleration of connecting rod, piston and crank effort, inertia of connecting rod, inertia force in reciprocating parts.

Balancing: Static and dynamic balancing, balancing of several masses in different planes, Balancing of reciprocating masses, balancing of locomotive, partial balancing, direct and reverse crank method, balancing of inline engines and V-Engines, balancing machines.

Lower Pairs: Pantograph, straight line mechanisms, engine indicators, automobile steering gears, Hooke's joint and Double Hooke's joint.

Gyroscope: Effect of gyroscopic couple on supporting and holding structures of machines. Gyroscopic effect on naval and air ships and automobiles.

Flywheels: Turning moment diagram for steam engine and four-stroke internal combustion engine and for multicylinder engines, fluctuation of energy and speed in flywheels, size of flywheel and flywheel for punching press.

Books Recommended

1. Bevan T, *"The Theory of Machines",* 3rd Edition CBS Publishers and Distributors (2002).
2. Shigley J E and Vickar J J, *"Theory of Machines and Mechanism",* 2nd Edition, McGrawHill, New Delhi (1995).
3. Wilson C and Sadler J, *"Kinematics and Dynamics of Machine",* 3rd Edition, Prentice Hall(2002).
4. Ratan S S, *"Theory of Machines",* 1st Edition, Tata McGraw Hill, New Delhi (1993).
5. Rao J S and Dukkipati R V, *"Mechanism and Machine Theory",* 2nd Edition, New Age International (P) Limited, Delhi (1992).

MEPC-206	Mechanics of Deformable Bodies	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: Strength of Materials (MEPC-201).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	3-D stress analysis: Analytical and graphical methods (Mohr's circle) understanding and problem solving.
CO 2	Basic concept of strain energy for 2-D and 3-D state of stress.
CO 3	Theories of Failure: Ability solve problem related to maximum stress, maximum strain, and strain energy theory of failure.
CO 4	Thick Cylinders and Bending of curved beams: Basic concept of design of thick cylinders and bending of curved beams and problem solving.
CO 5	Springs: Analysis of closed and open coiled helical, flat spiral, and leaf springs. Problem solving related to mentioned topics.
CO 6	Indeterminate systems: Basic concept of indeterminate structures and problem solving.
CO 7	Distribution of shear stress in beams: Derivation of general formula and its application to rectangular, triangular, I, C, T, L, circular and hollow sections and problem solving.

Detailed Syllabus

Strain energy: Energy of dilation and distortion, resilience stress due to suddenly applied loads, Castigliano's theorem, Maxwell's theorem of reciprocal deflection.

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum strain energy theory, maximum shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems only.

Distribution of Shear Stress in Beams: Derivation of general formula and its application to rectangular, triangular, I, C, T, L, circular and hollow sections.

Springs: Closed and open coiled helical springs: Derivation of formula and application fordeflection and rotation of free end under the action of axial load and or axial couple; flat

spiralsprings – derivation of formula for strain energy, maximum stress and rotation. Leaf spring,deflection and bending stresses

Thick Cylinders: Derivation of Lame's equations, calculation of radial longitudinal and hoopstresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunkon solid shafts.

Bending of curved beams: Calculation of stresses in crane or chain hooks, rings of circularsection and trapezoidal section and chain links with straight sides, Deflection of curved bars andrings.

Statically in determinant Systems: Force Method, Displacement method, Method ofsuperposition and Analysis by differential equation of the deflection curve.
Unsymmetrical bending: Shear center for angle, channel and Z sections.
Rotational stresses: Discs and rims, discs of uniform strength.
3 D stress analysis: Analytical and graphical methods (Mohr's circle).

Books Recommended

1. Timoshenko, S P, James M and Gere," Mechanics *of Materials",* 2nd Edition, CBSPublishers, New Delhi (1998).
2. Boresi A P, Schmidt R J and Sidebottom O M, *"Advanced Mechanics of Materials",* JohnWiley and sons Inc, New York (1993).
3. 3. Ryder GH, *"Strength of Materials",* 3rd Edition English Language Book Society / Macmillan Hongkong (2002).
4. Hibbeler, Russel C, *"Mechanics of Materials",* 4th Edition, Prentice Hall (2000).
5. Dieter G.E. *"Mechanical Metallurgy",* McGraw Hill, New York (1996).

MEPC-208	Production Processes	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Manufacturing Process (IPCI-101).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Analyze and calculate forging loads using slab model plane rolling, extrusion and wire drawing and sheet metal forming processes.
CO 2	Suggesting the simplified manufacturing processes with the aim of cost reduction and material wastage.
CO 3	Selecting the appropriate methods and tooling for typical applications in the industries to produce critical design components.
CO 4	Ability to clear the fundamental concepts of powder metallurgy, casting, welding, forming and the advance manufacturing processes.

Detailed Syllabus

Attributes of Manufactured Products: Mechanical properties, physical properties, chemical properties, geometric attributes, material selection.

Machining and Machine Tools: Elements of machining, classification of machine tools, concept of orthogonal metal cutting.

Metal Casting: Casting alloys, solidification of metals, melting and pouring, casting processes, finishing processes, designs for casting.

Welding Processes: Survey of welding processes.Weldability of Steels, Cast irons, aluminium and Copper alloys, Joint Design and specifications, Inspection of welds.

Forming Processes: Rolling, Drawing, Extrusion, Forging, Press working and die design and High Velocity Rate Forming.**Powder metallurgy:** Process details, component and die design considerations.

Processing of Plastics: Introduction and types of plastics, Properties of plastics, Materials required for processing plastics, Forming and Shaping of plastics, Comparison of plastic forming processes.

Jigs and Fixtures: Introduction, Production Devices, Advantages of Jigs and Fixtures, Elements of Jigs and Fixtures, Principles of Location and Clamping.

Process Planning: Definitions of process planning, contents of process planning, process operations, steps of process planning.

Books Recommended

1. Schey A J, *"Introduction to Manufacturing Processes",* McGraw Hill Book Company, New York (1987).
2. Sharma P C, "Production *Technology*", S Chand & Co, (2003).
3. DeGarmo E Paul, "*Materials & Processes in Manufacturing*", Wiley, 9th Edition.
4. Parmar R S, "*Welding Processes & Technology*", Dhanpat Rai Publishers.
5. Juneja B L, "*Fundamentals of Metal Cutting & Machine Tools*", New Age International(1998).

MEPC-210	Fluid Mechanics-II	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: Fluid Mechanics-I (MEPC-211)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To enable the students to appreciate the happening in the nature due to fluid flow motions and their causes and effects.
CO 2	To enable the students to learn about the mathematical modeling techniques for fluid mechanics problems.
CO 3	To understand the phenomenon of flow turbulence and its mathematical modeling.
CO 4	To enable the students to understand the importance of analytical approximate solutions.
CO 5	To enable the students to learn about various other solution techniques of mathematical modeled equations using computational methods.

Detailed Syllabus

Potential Flows

Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet,

Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta- Joukowski lift theorem; Concept of lift and drag.

Boundary Layer
Salient features of flow pattern in a boundary layer, Velocity and shear stress distribution alongthe boundary, similarity solutions, Von-Karman momentum integral equation, ApproximateMethods, quantitative correlations for boundary layer thickness, local skin friction coefficientand drag coefficient in laminar, turbulent and laminar turbulent combined boundary layer flowson a flat plate without pressure gradient, flow over a curved surface boundary layer separationand its control.

Turbulent Flow
Introduction, Fluctuations and time-averaging, General equations of turbulent flow, Reynolds averaging, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis, Turbulence modeling, Free turbulent flows.

Compressible Flows
Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Rankine-Hugoniot relations, Fanno and Rayleigh curve, Mach waves, Oblique shock wave, Prandtl-Meyer expansion waves, Quasi-one dimensional flows.

Introduction to Computational Fluid Dynamics (CFD)
Boundary conditions, Basics of discretization – Introduction to Finite Difference Method, FiniteVolume Method and Finite Element Method.

Books Recommended

1. Çengel, Y.A. and J.M. Cimbala, *Fluid Mechanics*, McGraw-Hill, Boston, MA. Web link.
2. Munson, B.R., D.F. Young, and T.H. Okiishi, *Fundamentals of Fluid Mechanics*, 4th ed., Wiley, New York, NY, 2002
3. White, F. M., *Fluid Mechanics*, Fifth Edition, McGraw Hill 2003.
4. Kundu, P. K., and Ira M. Cohen, *Fluid Mechanics*, 4th ed., Academic Press 2007.
5. White, F. M., Viscous *Fluid Flow*, 2nd Edition, McGraw Hill 1991.
6. Currie, I.G., *Fundamental Mechanics of Fluids*, 2nd Edition, McGraw Hill 1993.
7. Panton, R.L., *Incompressible Flow*, 2nd Ed., John Wiley & Sons, 1996.
8. Fay, J. A., *Introduction to Fluid Mechanics* Cambridge, MA: MIT Press, 1994. ISBN: 0262061651
9. Chevray, R. and J. Mathieu, *Topics in Fluid Mechanics*, Cambridge University Press, 1993.
10. Schlichting, H., *Boundary Layer Theory*, McGraw-Hill, 1968.
11. Batchelor, G.K., *An Introduction to Fluid Dynamics*, Cambridge University Press, 1967.
12. Aris, R., *Vectors, Tensors, and the Basic Equations of Fluid Mechanics*, Prentice-Hall, 1962.
13. Bird, R.B., W.E. Stewart, and E.N. Lightfoot (1960), *Transport Phenomena*, Wiley, New York.
14. Stefan Popes, *Turbulent Flows*, McGraw-Hill, Boston, MA.
15. Yahya, S.M., *Fundamentals of Compressible Flow*, New Age International Publisher, 2005.
16. Anderson, J. D., Computational Fluid Dynamics, McGraw-Hill Higher Education; 6th edition (1 April 1995).

MACI-201	Mathematics-III	Core Course	L	T	P	Credit
			3	1	0	4

Pre-requisites: Applied Mathematics-II (MACI-102)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	In analyzing of real to complex numbers and apply them whenever the problem arises in real analysis and calculus.
CO 2	To understand path and contour integrals.
CO 3	To apply different theorems of integral formulae.
CO 4	To evaluate some standard integrals using contour integrals.
CO 5	To evaluate the real integrals using special functions.
CO 6	To know the complex variable techniques and knowledge of mapping and transforms play a major role in several areas of engineering.

Detailed Syllabus

Limit and derivation of a complex function, analytic, functions and Cauchy Riemann equations, line integral of elementary functions, Cauchy's integral theorem, Cauchy's Integral formula and derivatives of analytic functions, Taylor and Laurent series, zeros and singularities, residues and residue theorem, evaluation of real improper integrals, conformal mapping, linear fractional transformations and mapping by elementary functions.

Series solution of differential equations, Bessel's differential equation and Bessel functions and their properties, differential equations reducible to Bessel's differential equations, Legendre's differential equation, Legendre's polynomials and their properties, Fourier-Legendre expansion of a functions.

Fundamental concepts of calculus of variations, functional involving several independent functions, one end fixed and other end free problems, both end free problems, constrained extreme.

Book Recommended:

1. B S Grewal, "*Higher Engineering Mathematics*". 35th ed., Khanna Publsihers, Delhi.
2. L E Elsgole, "*Calculus of Variations*", Addison-Wisley Publishing Company.
3. J B Conway, "*Functions of One Complex Variables*", Narosa Pblishing House, 1980.

MEPC-214	Production Processes Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students will be conversant with the software's like Auto Cad, Solid Works etc.
CO 2	To be able to understand the application of the different joining techniques, and

	be able to select an appropriate technique according to a specific requirement.
CO 3	Students should be able to analyze the effect of various welding process parameters on the bead geometry.
CO 4	Students should be able to design gating and risering system for a given casting.
CO 5	Students should be able to understand AFM, EDM machining process.
CO 6	To understand the different wear mechanisms, how they occur, and how to analyze&interpret wear-related problems of tools.

Detailed Syllabus

A small project covering the various aspects of Engineering from Design to Fabricationcomprising of the following:

(i) Preparation of Engineering Drawing on any CAD software – Weightage 20%.
(ii) Preparation of Bill of materials along with cost estimate (from market)- Weightage 10%.
(iii) Process Planning with details of Machines and tools required - Weightage 20%.
(iv) Completion of Project- Weightage 50%.

NOTE: Group size of minimum 2 students and maximum 3 students shall be used.

MEPC-301	Design of Machine Elements-I	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Analysis of Selection of materials for different mechanical component.
CO 2	Use the knowledge of other subject like mathematics, science and material science for designing purpose.
CO 3	Design the individual component for the mechanical system.
CO 4	Practical approach for designing and analysis of component of machine.

Detailed Syllabus

Scope and meaning of Design with special reference to machine Design, Design process.

Various considerations required for design of a component: Concept of tearing, bearing, shearing, crushing, bending etc. Selection of materials, mechanical behavior of materials, Stress concentration, factor of safety under different loading conditions, design stresses for variable and repeated loads, endurance limit, fatigue strength, Basic Principles of fatigue fracture, mechanism of fatigue, stress cycles, S-N curve, effect of mean stress on fatigue, cyclic stress-strain curve, Introduction to fracture and fracture mechanisms, Fits, tolerances and surface finish.

Fasteners and joints: Screws and screw jack, bolts, preloaded bolts subjected to shear, and torsion. Bolted, Welded and Riveted joints, eccentrically loaded welded and riveted joints, Cotter and cotter joints, pin fasteners, Knuckle joints.

Transmission shafts: Design of shaft subjected to static loading: pure torsion, simple bending, combined bending and torsion, combined bending torsion and axial loads. Design of shaft for fluctuating loads.

Keys: Different types of keys and splines, representations and use in Couplings.

Rigid couplings: Sleeve couplings, Flange couplings, Flexible couplings: Bush pin type, Universal type.

Levers: Hand and foot levers, cranked lever.

Gaskets, seals, Pipe joints: Oval, circular and square pipe joints.

Brakes and Clutches: Brakes: Design consideration of brakes, Flat plate, and conical plate clutches.

Books Recommended

1. Norton L R, *"Machine Design an Integrated Approach",* Pearson Education Asia, IstIndian Reprint, 2001.
2. Sharma P C and Aggrawal D K, *"A text book on Machine Design",* S K Kataria & sons, 9th ed.,2000.

3. Bhonsle R S and Weinmann J K, *"Mathematical modeling for Design of Machine Components",* TK Integrated, Prentice Hall, 1999.
4. Spotts M F and Shoup T E, *"Design of Machine Elements",* Prentice Hall 7th ed.,1998.
5. Shigley J E and Mischke C R, *"Mechanical Engineering Design",* Tata Mcgraw Hill, NewDelhi, 2003.
6. Bhandari V. B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd ed., 2007.

MEPC-303	Heat Transfer	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Applied Thermodynamics-I (MEPC-207), Applied Thermodynamics-II (MEPC-202).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To enable the students to understand the physics of different modes of heat transfer and importance of the subject of heat transfer in day to day life and in engineering applications.
CO 2	To enable the students to take up different problems related to heat transfer and write the corresponding mathematical models for them.
CO 3	To make students appreciate that the theoretical solutions are convenient ways to solve physical problems and also aware the students about the limitations of the theoretical solutions.
CO 4	To develop a competence in the students to solve heat transfer problems analytically by incorporating appropriate approximations in the complex models.
CO 5	To make the students understand the importance information of fluid mechanics in solving the coupled problems involving fluid flow and heat transfer.
CO 6	To make the students understand the importance of studying the course of m athematics in solving complex engineering problems theoretically with special reference to the problems on heat transfer in various modes.

Detailed Syllabus

Introduction: Concept of heat transfer, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Different modes of heat transfer: conduction, convection and radiation.

Conduction: Fourier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and itsmeasurement; Three- dimensional general heat conduction equation in rectangular, cylindrical and spherical coordinates. Derivation of equations for simple one dimensional steady state heat conduction from three dimensional equations for heat conduction though walls, cylinders and spherical shells (simple and composite), electrical analogy of the heat transfer, equivalent areas,
shape factor, conduction through edges and corners of walls and critical thickness of insulation layers on electric wires and pipes carrying hot fluids. Internal generation cases

along with some practical cases of heat conduction like heat transfer through underground electrical cables, simple model of heat conduction through piston crown and case of nuclear fuel rod with cladding. Influence of variable thermal conductivity on conduction, Introduction to unsteady heat transfer; Newtonian heating and cooling of solids; lumped capacitance method, semi-infinite solid technique for transient heat conduction solutions.

Theory of Fins: Straight rod type fins of uniform cross-section; Straight fins with varying cross-sectional area and having triangular or trapezoidal profile area, circumferential fin of rectangular cross-section provided on the circumference of a cylinder; optimum design ofstraight fin of rectangular and triangular cross-sections; fin effectiveness and fin efficiency; Application of fins in temperature measurement of flow through pipes and determination of error in its measurement.

Convection: Free and forced convection, derivation of three dimensional mass, momentum and energy conservation equations (with introduction to Tensor notations). Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Theory of dimensional analysis as applied to free and forced convective heat transfer. Analytical formula for heat transfer in laminar and turbulent flow; flow over vertical and horizontal tubes and plates; Newton's law of cooling; Overall coefficient of heat transfer; Different design criterion for heat exchangers; Log mean temperature difference for evaporator and condenser tubes, parallel and counter flow heat exchangers; Calculation of number and length of tubes in a heat exchanger.

Convection with Phase Change: (Boiling and Condensation) Pool boiling, forced convection boiling, heat transfer during pool boiling of a liquid. Nucleation and different theories of nucleation, different theories accounting for the increased values of heat transfer coefficient during nucleate phase of boiling of liquids; different phases of flow boiling (theory only)

Radiation: Process of heat flow, definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies, Planck's law of monochromatic radiation.Kirchoff's law and Stefan Boltzman's law. Interchange factor. Lambert's cosine law and the geometric factor. Intensity of Radiation, radiation density, irradiation, radiosity and radiation shields. Derivation of formula for radiation exchange between two bodies using the definition of radiosity and irradiation and its application to cases of radiation exchange between three or four bodies (e.g., boiler or other furnaces).Error in Temperature measurement by a thermocouple probe due to radiation losses.

Books Recommended

1. Theodore L. Bergman, Frank P. Incropera, David P. DeWitt, Adrienne S. Lavine, "*Fundamentals of Heat and Mass Transfer*", John Wiley & Sons, 2012.
2. Çengel, Y.A., "*Heat and Mass Transfer- A Practical Approach*", McGraw-Hill, Boston, MA.
3. Holman J P, "*Heat Transfer*", McGraw Hill Book Company (1997).
4. McAdam W H, "Heat Transmission", McGraw Hill Book Company, New York (1954).
5. Drake R M and Eckert E R G, "*Heat and Mass Transfer*", McGraw Hill, Kogakusha (1972).
6. Kreith F, "*Principles of Heat Transfer*", PWS Publishing Company, Boston (1997).
7. Rao Y V C, "Heat Transfer", University Press, Hyderabad (2001).

MEPC-305	I.C. Engines and Emission Control	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Applied Thermodynamics-I (MEX-207), Applied Thermodynamics-II (MEX-202).

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO 1	Learn to classify different types of internal combustion engines and their applications, Demonstrate a basic understanding of engine function, performance, fuels for IC engines and design methodology.
CO 2	Analyze thermodynamic cycles for Otto, Diesel cycles, striling, Carnot and duel cycle, Given an engine design specification, predict performance and fuel economy trends with good accuracy.
CO 3	Determine and understand the effects of spark timing, valve timing, A/F ratio, engine geometry, fuel type, and manifold tuning on engine performance and emissions, Understanding of the performance and emission analysis of internal combustion engine and after treatment devices.

Detailed Syllabus

Introduction to IC Engines: Heat Engine versus Internal Combustion Engine, Historical development of IC Engines, Classification and Nomenclature, Applications of IC Engines. Review of Air standard cycles: Carnot, Sterling, Ericsson, Otto, Diesel and Dual Cycle etc.

Working of IC Engines: Working of 4 stroke SI and CI Engines and their valve timing diagram, working of 2-stroke SI and CI engines and their valve timing diagrams, Comparison of two stroke and four stroke Engines, Fuel Air Cycles and their analysis: Composition of cylinder gases, variable specific heats, Dissociation, Effect of number of moles, Air standard versus fuel air cycles, Effect of operating variables like compression ratio, fuel air ratio. Actual engine cycles and losses: Comparison between Actual, Fuel- Air cycle, Air standard cycles for S.I. and C.I engines.

IC Engine Fuels: Requirements of fuel in I C engines, Type of Fuels- Solid, Liquid and Gaseous fuels, Chemical structure of petroleum, petroleum refining process, Important qualities of SI and CI engine fuels and their ratings. Combustion of Fuels: Heating values of Fuels, Theoretical determination of heat of reactions of fuel, Combustion equation for Hydrocarbon fuels, Determination of minimum air required for combustion, conversion of volumetric analysis to mass analysis, Determination of air supplied from volumetric analysis of Dry flue gases, Determination of excess air supplied, Determination of percentage of carbon from exhaust gas composition.

Mixture Preparation Systems: Fuel supply system and fuel pumps, Simple carburetor and its working, approximate analysis of single jet carburetor, Actual Air fuel calculation of single jetcarburetor, Ideal requirements from an ideal carburetor, limitations of single jet carburetor, Different devices used to meet the requirements of an ideal carburetor, Different modern carburetors, Petrol injection. Fuel Injection systems for CI Engines: Classification of Injection Systems, Injection Pump, Fuel Injector, Nozzle, and Injection in SI Engines.

Combustion in SI Engine: Stages of Combustion in S I Engine, flame front propagation, factors influencing the flame speed, ignition lag and factors affecting the ignition lag,

Abnormal combustion and knocking, control and measurement of knock, Anti knock agents, combustion chambers of S I engines.

Combustion in CI Engines: Stages of combustion, Delay period, factors affecting delay period; detonation and factors affecting detonation; comparison of abnormal combustion in SI & CI engine, rating of IC engine fuels, combustion chambers for IC engines.

Supercharging: Purpose of supercharging, types of superchargers.Analysis of superchargers. Arrangement of supercharger and its installation, turbo charged engines, supercharging of SI & CI engines, limitations of supercharging.

Measurement and Testing: Measurement of Friction Power, Brake Power, indicated Power, Measurement of Speed, Air consumption, fuel consumption, heat Balance Sheet for engine, governing of IC Engines. Performance Characteristics of IC Engines: Performance parameters, performance of SI engines, performance of C.I. engines, Engine performance maps.

Emission and Control: Emission of various pollutants from the engine, kinetics of NOx formation,NO formation in S.I.engines, NOx formation in C.I.engines, Emission of carbon monoxide, HC emission in S.I.engine and hydrocarbon emission in C.I engine, particulate emissions in S I engine ,characteristics of diesel particulates, Soot formation fundamentals, Exhaust gas treatment: Catalytic convertors, Thermal reactors, Particulate traps.

Books Recommended

1. Heywood J B, *"Internal Combustion Engine Fundamentals"*, McGraw Hill, Publication, New Delhi (1988).
2. Taylor C F, *"The Internal Combustion in Theory and Practice"*, Volume I and II, MIT Press, Cambridge, Mass (1968).
3. PulkRabek W W, *"Engineering Fundamentals of Internal Combustion Engine",* Pearson Education, New Delhi (2003).
4. Stone R, *"Introduction to Internal Combustion Engines"*, 2nd Edition, Macmillan (1993).
5. Milton B E*, "Thermodynamics, Combustion and Engines"*, Champman and Hall (1995).

MEPC-307	Mechanical Measurement & Metrology	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students will be able to understand the operating principles of a range of widely used instrumentation techniques and will know how to use them in the design of measurement systems.
CO 2	To familiar with various standards and calibration methods used in industry.
CO 3	To be familiar with different sensors and transducers and to conceptualize the suitable measurement technique.
CO 4	Use basic statistical methods to aid data evaluation and decision making.
CO 5	Understand the formal metrology concepts in designing and using measurement systems.

Detailed Syllabus

General Concept: Need and classification of measurements and instruments, Standards, Calibration, basic and auxiliary functional, elements of a measurement system, mechanical versus electrical/electronic instruments, primary, secondary and working standards.

Static and Dynamic Characteristics of Instruments: Range and span, accuracy and precision, Calibration, hysterics and dead zone, sensitivity and linearity, threshold and resolution, speed of response, lag, fidelity, and dynamic errors, dead time and dead zone. Sources of errors in measurements, Basic concepts of measurement methods, Processing of experimental data, curve fitting. regression analysis and Uncertainty analysis.

Functional Elements: Review of electro-mechanical sensors and transducers-variables resistance, inductance and capacitive pick-ups, resistance strain-gauges, gauge-factor, boned and unbounded strain gauges, surface preparation and Bonding Techniques, application of strain-gauges for direct, bending and torsional loads, hydraulic and pneumatic load cells.

Temperature Measurement: Bimetallic thermometers, liquid-in-glass thermometers and filledin-system Thermometers, thermocouples, metal resistance thermometers and thermistors.

Pressure and Flow Measurement: Bourdan Tube, Vacuum Measurement-Mcleod Guage, Thermal Conductivity gauge and Ionization gauge. Electromagnetic flux-meters, Ultrasonic Flow meters and Hot Wire anemometers.

Force, Torque and Power Measurement: Vibration Reed tachometer, Stroboscope, Proving Ring, Mechanical and Hydraulic Load cell, Torque on rotating shafts, Absorption, transmission and driving dynamometers.

Data Sampling and Data Acquisition: Sampling concepts, Data Acquisition systems and its components

Metrology: linear Measurements-Vernier caliper and vernier height gauge. Angular Measurements: Sine bar, clinometers, angle gauges, vernier bevel protector, Comparators: Their types, relative merits and limitations, use of comparators, construction of Mechanical, electrical & optical comparators, Measurement of tooth thickness, pitch and checking of profile for spur gears, Measurement of major diameter, minor diameter, effective diameter pitch, angle of screw thread.

Books Recommended

1. Holman J P, *"Experimental Methods for Engineers"*, 6th Edition, McGraw Hill Inc (1994).
2. Doeblin E O, *"Measurement System Application and Design"*, 5th Edition, Mcgraw Hill, Singapore (2004).
3. Beckwith T G, Marangoni R D and Lienhard J H, *"Mechanical Measurements"*, 5th Edition, Pearson Education India, (1993).
4. Jain R K, *"Engineering Metrology"*, 3rd Edition Khanna Publishers, Delhi (1998).
5. Figloila RS and Beasley D E, *"Theory and Design for Mechanical Measurements"*, 2nd Edition, John Wiley and Sons Inc, New York (1995).

MEPC-309	Mechatronics	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understanding of the Mechatronics approach; Binary arithmetic and Boolean Logic; Formulate automation problems based on Boolean Logic; Design, simplify and optimize circuits for automation problems.
CO 2	Ability to develop Mechatronic products for automation in industry conceptually.
CO 3	Understand and apply concepts of Digital and Analog domains; Design mechatronic devices based on Digital input, Digital output, Digital to Analog and Analog to Digital.
CO 4	Mini project work based on 8-bit microcontrollers with a view to develop ability of self-learning, working in a team.
CO 5	Understand and apply detailed concepts relating to actuators, sensors, and their integration with drives and signal conditioning.
CO 6	Develop ability and competence in modeling, simulation and control of Mechatronic systems in multi-energy domains.

Detailed Syllabus

Introduction: Mechatronics: What and Why?

Essential electronics and Boolean algebra:
Digital representation: Binary, Decimal, Hexadecimal, Conversion from Binary to Decimal and vice-versa,

Binary arithmetic: Addition, Subtraction: 2's complement, Multiplication and Division, Boolean algebra: AND, OR, NOT, NAND, NOR, XOR logic, Truth table, Realization of logic in physical systems: switches-LEDs, cylinders. Fundamental identities, De Morgan's theorems and relationship with sets, Simplification.

Electronics fundamentals: Review of some semiconductor devices, Concepts of Digital and Analog systems, Digital output (DO) and input (DI), Using switches, transistors, pneumatic devices, etc. to realize DI & DO.

Operational Amplifier: Principles, Configurations: Inverting; Summing; Integrating and Differentiating configurations, Digital to Analog conversion (DAC), The R-2R and summing Op-Amp circuit, Analog to Digital conversion (ADC), Successive approximation method, Flash method, etc., Programs for DI, DO, DA and AD for PC based plug in cards.

Microprocessor, Computers and Embedded systems: Introduction to the 8085 (8-bit microprocessor) and microcontroller: Architecture, programming, I/O, Computer interfacing, Programmable logic controller basics.

Sensors and actuators: Strain gauge, resistive potentiometers, Tactile and force sensors, tachometers, LVDT, Piezo electric accelerometer, Hall effect sensor, Optical Encoder,

Resolver, Inductosyn, Pneumatic and Hydraulic actuators, stepper motor, DC motor, AC motor.

Control Systems: Mathematical modeling of Physical systems, System equations, Controllability and Observability, Pole placement, PID controller, Control of Hydraulic, Pneumatic, Mechanical and Electrical Systems.

Integration and case studies: Integration of Mechatronics component subsystems into a complete Mechatronics System Applications to CNC machines and Robotics.

Books Recommended

1. David G. Alciatore, and Michael B. Histand, *"Introduction to Mechatronics and Measurement Systems",* 3rd Edition, Tata McGraw Hill Publishing Company Ltd., NewDelhi (2007).
2. W.Bolton, *"Mechatronics",* 2nd Edition, Pearson Education Asia, New Delhi (2001).
3. Dan Necsulescu, *"Mechatronics",* Pearson Education Asia, New Delhi (2002).
4. N. P. Mahalik, *"Mechatronics",* Tata McGraw Hill Publishing Company Ltd., New Delhi(2003).
5. Wolfram Stadler, *"Analytical Robotics and Mechatronics",* McGraw-Hill Book Co.,Singapore (1995).
6. Eronini Umez-Eronini, *"System Dynamics & Control",* Thomson Asia Pvt. Ltd., Singapore(1999).
7. Shetty Devdas and Richard A Kolk, *"Mechatronics System Design",* Thomson Learning,Vikas Publishing House, New Delhi (2001).
8. IEEE Robotics & Automation Magazine, Special Issue on Mechatronics, June 2001.

HMCI-202	Entrepreneurship Development and Management	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To familiarize with basics of entrepreneurship
CO 2	To generate the spirit of entrepreneurship

Detailed Syllabus

Entrepreneurial mind for entrepreneurial society, Entrepreneurship vs unemployment, fundamentals of entrepreneurship, entrepreneurial development in emerging markets, entrepreneurial leadership, intrapreneurship, creativity, innovation and business ideas, ideas to opportunity, the entrepreneurial process, entrepreneurial support system, planning small scale industry. business plan, intellectual property rights, human resource plan, recruitment, selection, placement and induction, training and development, marketing plan, operation and production plan, venture team, insights from financial statements, financing venture; role of financial institutions and micro finance, launching a venture, managing growth, from start-up to going public. Women entrepreneurship, rural entrepreneurship.Sickness in small sector; reasons and rehabilitation.

Course Outcomes

- The students will be able to develop and demonstrate entrepreneurial abilities both at work place and at their ventures.
- The students will be able to manage their own enterprises effectively through creative thinking, innovation and leadership.

Books Recommended

1. Arya Kumar (2012), Entrepreneurship, Pearson.
2. H Nandan (2013), Fundamentals of Entrepreneurship, PHI.
3. Jeffry A Tommons and Stephen Spinelli (2009), New Venture Creation, Tata McGraw Hill.
4. Sangeeta Sharma (2016), Entrepreneurship Development, PHI.

MEPC-311	Applied Thermodynamics Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: Applied Thermodynamics-I (MEPC-207), Applied Thermodynamics-II (MEPC-202).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Perform the load test on petrol/ diesel engine and draw the performance characteristics.
CO 2	Determine the volumetric and isothermal efficiency of two stage air compressor.
CO 3	Determination of IP, BP and FP by Morse test in a Multicylinder Petrol engine.

List of Experiments

1. To conduct a load test on a single cylinder, 4 stroke petrol engine and study its performance under various loads.
2. To conduct a load test on a single cylinder high speed diesel engine to study its performance under various loads.
3. To conduct a performance test of a single cylinder high speed diesel engine and to study its performance under different loads.
4. To conduct the experiment on two stroke air compressor and to find out its volumetric efficiency and isothermal efficiency.
5. To study the effect of forward curved, backward, curved and radial vanes in a centrifugal compressor and to find out the overall efficiency of the compressor.
6. To determine the volumetric and isothermal efficiency of two stage air compressor.
7. To study the performance of axial flow fan.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

MEPC-313	Design of Machine Elements-I Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites:
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Compare the mechanical properties of different materials by testing
CO 2	Design the various mechanical components required for different circumstances
CO 3	Design a system using different components and having knowledge of simulation.

List of Experiments

1. Design based strength consideration (ductile and brittle material).
2. Design based on stability and yield consideration.
3. Design involving both yield and fatigue failure.
4. Design involving material selection and probabilistic approach.
5. Design of shafts (considering both yield and fatigue).
6. Design of Brakes
7. Design of Clutches
8. Design project involving multiple machine components: The project should expose the students to some aspects of system design such as selection and configuration of the machine elements involved considering different alternatives to developing a final system with dimensions using MATLAB software.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

Books Recommended

1. Mechanical Engineering Design by J.E. Shigley, C.R. Mischke & R.G. Budynas, McGraw Hill.
2. Machine elements in Mechanical Design by R.L. Mott, Prentice Hall.
3. Mechanical Design by P. Childs, Elsevier.
4. Fundamentals of Machine Component Design by R. C. Juvinall & K. M. Marshek, Wiley.
5. Machine Design by R.L. Norton.

MEPC-315	Heat Transfer Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: Applied Thermodynamics-I (MEPC-207), Applied Thermodynamics-II (MEPC-202).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To make students understand of experimental procedure to solve heat transfer problems by selecting some physical situations pertaining to different modes of heat transfer.
CO 2	To make students understand the measurement procedure for monitoring the

	physical parameters like temperature, flow velocity and energy.
CO 3	To make students understand the experimental data analysis and the errors involved in experimental measurements and discuss the correct measurement techniques to acquire most reliable information.
CO 4	To teach students the correct way to write the report based on experimental observations.

List of Experiments

1. To study and compare temperature distribution, heat transfer rate, overall heat transfer in parallel flow and counter flow heat exchanger.
2. To study the heat transfer and counter flow heat exchanger.
3. To find the thermal conductivity using two slab guarded ho plate method.
4. To determine heat transfer coefficient in natural convection.
5. To determine heat transfer coefficient in forced convection for air flowing in a tube.
6. To determine heat transfer coefficient in drop wise and film wise condensation.
7. To determine the emissivity of a given plate at different temperatures.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

MEPC-317	Mechanical Measurement & Metrology Lab	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Introduction to various mechanical Instruments.
CO 2	Students will Enable to understand the working Principles of various mechanical instruments.
CO 3	Enable to understand the application of various mechanical Instruments.

List of Experiments

1. Measurement with the help of Vernier caliper and micrometre.
2. Measurement of an angle with the help of sine bar.
3. Measurement of surface roughness.
4. Measurement of gear elements using profile projector.
5. Three wire method to determine effective diameter of external threads.
6. Measurement of thread element by Tool makers microscope.
7. Calibration of a pressure gauge with the help of a dead weight guage tester.
8. Use of stroboscope for measurement of speed of shaft.
9. Use of pilot type to plot velocity profile of a fluid through a circular duct.
10. Preparation of a thermocouple, its calibration and application for temperaturemeasurement.
11. Measurement of flow using (i) Rotameter (ii) Venturimeter (iii) Orifice meter
12. Measurement of power using dynamometer.
13. Measurement of Load using Load cell.
14. Measurement of strain using strain meter.

MEPC-302	Fluid Machinery	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Impulse momentum theorem, Analysis of Impact of jets on different types of vanes, Jet propulsion.
CO 2	Study of hydraulic turbines like Pelton, Francis and Kaplan turbines including their performance analysis, cavitations in turbines, similarity analysis.
CO 3	Study of different types of pumps like centrifugal pumps and reciprocating pumps, including its performance analysis.
CO 4	Study of hydraulic devices like hydraulic intensifier, hydraulic press, torque convertor, hydraulic accumulator, etc.

Detailed Syllabus

General Concepts: Impulse momentum principle, jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the center and tangentially at one end of the vane, calculations for force exerted, work done and efficiency of jet. Basic components of a turbomachine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid, Euler's equation for energy transfer in a turbomachine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes.

Pelton Turbine: Components and its operation, velocity triangles for different runners, work output, Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions. Francis and Kaplan Turbines: Components and operation, velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction, draft tubes – its function and types. Function and brief description of commonly used surge tanks.

Centrifugal Pumps: Layout and installation; Main elements and their functions, Various types and classification, Pressure changes in a pump - suction, delivery and manometric heads, vane shape and its effect on head-capacity relationships, Departure from Euler's theory and losses, pump output and efficiency, Minimum starting speed and impeller diameters at the inner and outer periphery, Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation, Axial and mixed flow pumps, Troubleshooting - field problems, causes and remedies. Similarity Relations and Performance Characteristics: Unit quantities, specific speed and model relationships, scale effect, cavitation and Thoma's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting.

Reciprocating Pumps: Components parts and working, pressure variations due to piston acceleration, acceleration effects in suction and delivery pipes, work done against friction, maximum permissible vacuum during suction stroke, Air vessels.

Hydraulic Devices and Systems: Construction, operation and utility of simple and differential accumulator, intensifier, fluid coupling and torque converter, Air lift and jet pumps; introduction to gear, vane and piston pumps.

Books Recommended

1. Daughaty R L, *"Hydraulic Turbines",* McGraw Hill Book Company (1965).
2. Jagdish Lal, *"Hydraulic Machines",* Metropolitan Book Company Private Limited, New Delhi, (2000).
3. Stepanoff A J, *"Centrifugal and Axial Flow Pumps",* John Wiley and Sons (1970).
4. Binder R C, *"Advanced Fluid Mechanics and Fluid Machinery",* Prentice Hall (1966).
5. Nechleba M, *"Hydraulic Turbine",* Constable and Company (1957).

MEPC-304	Industrial Automation	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Characterize the architecture of Hydraulic Systems, Pneumatic Systems, Mechanization, Industrial Robots.
CO 2	Apply the knowledge gained to design and simulate hydraulic and pneumatic circuits.
CO 3	Analyze the application of Mechanization systems and Industrial Robots for various applications.
CO 4	Propose a suitable automation solutions meeting the requirements.

Detailed Syllabus

Introduction: Basic concept of Automation, Types of Automation, Feasibility etc. **Industrial**

Hydraulics: Introduction, basic concepts, Hydraulic fluids, Classification and properties of hydraulic fluids, Contaminates in hydraulic system, control and cleanliness standards, Fluid power generators, i.e. Gear, Vane, Piston pumps, linear and Rotary Actuators, Direction Control Valves, types, actuation methods, pressure control valves; pressure reducing valves, pressure relief valve, Unloading valve, Sequence valve, Counterbalance valve, Flow control valves simple and pressure compensated type. Standard ISO Symbols for Hydraulic Components. Sealings in hydraulic system, Accumulators, hydraulic hoses and tubing, Design and analysis and hydraulic circuits, conventional as well as computer aided design.

Pneumatics: Introduction, Basic components, Source, storage and distribution, treatment of compressed air, linear and Rotary actuators, Direction control valves – types, actuation methods, pressure control valves, logic devices – twin pressure valve, shutter valve, time delay valve, Pneumatic circuit design and analysis, conventional as well as computer aided design.

Automatic Assembly System: Development of Automatic Assembly process, Transfer devices – continuous, Intermittent, synchronous and asynchronous, Vibratory feeders – Mechanics, effect of frequency, acceleration, track angle, friction, load sensitivity, orientation

of parts – active and passive devices, Mechanical feeders – computation and operational details, feed tracks, Escapement devices. Product design for high-speed automatic assembly, examples of design modifications.

Mechatronics: Introduction mechatronic system design, sensors and transducers for displacement, proximity, velocity, force, pressure temperature measurement. Microprocessors – Introduction, structure micro-controllers, application programmable logic controllers – basic structure, specifications programming of PLC's, importance of Timers, Counters, marker relays, analog comparators in PLC programming, Introduction to Data Acquisition and virtual instrumentation using LABVIEW.

Robotics: Basic concepts, classification based on Geometry, programming, drives, work volume of robots world and joint coordinates various joints, DOF, end effectors – Types and uses, Sensors in Robots, programming – Teach pendant and Computer programming, Introduction to forward and inverse kinematics, Applications of Robots.

Books Recommended

1. Anthony Esposito, *"Fluid Power with Application",* 5th Edition, Pearson Education (2003).
2. Majumdar S R, *"Oil Hydraulic System"*, Tata McGraw Hill (2001).
3. Bolton W, *"Mechatronics"*, 2nd Edition, Pearson Education, New Delhi (1999).
4. Necsulelscu Dan, *"Mechatronics"*, Pearson Education, New Delhi (2002).
5. Geoffrey Boothroyd, "Assembly Automation and Product Design", Marcel Dekker In

MEPC-306	Design of Machine Elements-II	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Analysis of Selection of materials for different mechanical component.
CO 2	Design the individual component for the mechanical system.
CO 3	Practical approach for designing and analysis of component of machine.

Detailed Syllabus

Spur Gears: Terminology, Forces analysis, Beam strength of spur gear tooth. Lewis Equation and form factor, Design for strength, Dynamic Load and wear load.

Helical Gears: Terminology, Forces analysis, formative/virtual number of teeth, Beam strength of helical gear tooth. Lewis Equation and form factor, Design for strength, Dynamic Load and wear load.

Worm Gears: Terminology, Forces analysis, efficiency of worm and worm gear, worm gear strength, Thermal capacity of worm gear sets.

Bevel Gears: Terminology, Forces analysis, formative/virtual number of teeth, Beam strength of straight tooth Bevel gear, Design for strength, Dynamic Load and wear load.

Springs: Types of Springs, terminology – Stresses in Helical coil springs of circular and non-circular cross sections. Concentric springs, springs under fluctuating loads, - Energy stored in springs, torsion, Belleville springs. Leaf Springs: Stresses in leaf springs, Nipping. Equalized stresses.

Lubrication: Lubricants and their properties, Modes of Lubrication (Hydrodynamic & Hydrostatic)

Sliding Contact Bearings: Journal bearing-Terminology, Bearing Modulus, Minimum oil film thickness. Coefficient of Friction, Summerfield number, Heat generated & Dissipated.Design of journal bearing using Petroff 's,McKee's equation and Raymond & Boyd charts,tables. Footstep & collar Bearing.

Rolling Contact Bearings: Types & classification, Terminology- Life, Static & dynamic load capacity, equivalent load, Load-life relationship, Design – finding Life, selection from manufacturer"s catalogue.

IC Engine parts: flywheel, piston and cylinder,

Books Recommended

1. Design of Machine Elements - V.B.Bhandari, 2nd Edn 2007,TataMcgrawhill
2. Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke, 6th Edition 2003 Tata McGraw-Hill

Design Data Handbooks

1. Design Data Handbook – K.Lingaiah, Mcgraw hill, 2nd Ed 2003.
2. Design Data Hand Book – K.Mahadevan and Balaveera reddy, Cbs Publishers & Distributors.
3. PSG Design Data Hand Book PSG College of Technology

MEPC-308	Numerical Methods in Mechanical Engineering	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Applied Mathematics-I (MACI-101), Applied Mathematics-II (MACI-102), Mathematics-III (MACI-201).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To attain knowledge of finding the roots of algebraic and transcendental equations this is a problem of great importance in applied mathematics by various numerical methods.
CO 2	To understand direct and iterative methods for solving linear system of equations.
CO 3	To attain knowledge of eigen value problems and several methods of finding the inverse of matrix which require less of computational labour and can be easily extended to matrices of higher order.

CO 4	To understand interpolation, numerical differentiation and integration using basic concepts of finite differences.
CO 5	To apply various numerical methods for solving ordinary differential equations where solutions cannot be obtained using available analytical methods and even to solve ordinary differential equations which have analytical solutions with greater ease.
CO 6	To understand finite difference methods for boundary value problems and for elliptic, parabolic and hyperbolic partial differential equations which arise in description of physical processes in applied sciences and engineering.

Detailed Syllabus

Roots of algebraic and transcendental equations, Bisection method, Regula-Falsi method, Newton Raphson method, Bairstow's method and Graeffe's root squaring method.

Solution of simultaneous algebraic equations, matrix inversion and Eigen-value problems, triangularisation method, Jacobi's and Gauss-Siedel iteration method, partition method for matrix inversion, power method for largest eigen-value and Jacobi's method for finding all Eigen-values.

Finite differences, interpolation and numerical differentiation, forward, backward and central differences, Newton's forward, backward and divide difference interpolation formulas, Lagrange's Interpolation formula, Stirling's and Bessel's central difference interpolation formulas numerical differentiation using Newton's forwarded and backward difference formulas and numerical differentiation using Stirling's and Bessel's central difference interpolation formulas.

Numerical integration, Trapezoidal rule, Simpson's one-third rule and numerical double integration using Trapezoidal rule and Simpson's one-third rule.

Taylor's series method, Euler's and modified Euler's methods, Runge-Kutta fourth order methods for ordinary differential equations, simultaneous first order differential equations and second order differential equations.

Boundary value problems, finite difference methods for boundary value problems.

Partial differential equations, finite difference methods for elliptic, parabolic and hyperbolic equations.

Books Recommended:

1. S S Sastry, Introductionary Methods of Numerical Analysis, 3rd Edition, Prentice Hall of India Pvt. Lrd., New India-1999.
2. S C Chopra and R P Canale, Numerical Methods for Engineers, 2nd Edition, McGraw Hill Book Company, Singapore 1990.
3. B S Grewal, "Numerical Methods", Khanna Publishers. Delhi.

MEPC-310	Fluid Mechanics and Fluid Machinery Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To study the fluid characteristics of pressure, velocity and flow rate.
CO 2	To study the friction in pipes and test on Venturimeter and Bernoulli's apparatus.
CO 3	To study the performance of the Pelton turbine, Francis turbine and Kaplan turbine in terms of parameters like hydraulic efficiency, mechanical efficiency and its variation with head and discharge.
CO 4	Performance of centrifugal pump in terms of terms of hydraulic efficiency, mechanical efficiency and its variation with head and discharge.

List of Experiments

1. Flow through Orifice
   a) Constant Head Method and Variable Head Method
2. Determine the coefficient of discharge of notch (V or rectangular type).
3. Flow through Venturimeter
4. Determine the metacentric height of a floating body.
5. Flow through Pipes
6. Verification of Bernoulli's Apparatus
7. Determine the coefficient of impact of vanes (momentum theorem application) in an impact of jet apparatus.
8. To draw characteristics of Francis turbine.
9. To draw the characteristics of Pelton Turbine.
10. To draw the characteristics of Kaplan Turbine.
11. To draw the various characteristics of Centrifugal pump.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

MEPC-312	Industrial Automation & Mechatronics Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To attain knowledge about the architecture and programming of Industrial Robotic systems.
CO 2	To study the working of various Hydraulic and pneumatic components.
CO 3	To carry out the designing and simulation of Hydraulic and Pneumatic Circuits using Trainer Board and Software.
CO 4	To study the use of various types of sensors in automation systems with examples.

List of Experiments

1. Study of various pneumatic components and Assembly and operation of some basic pneumatic circuits using pneumatics transfer package.
2. Study of various electro-pneumatic Components and Assembly and operations of some basic and advanced electro-pneumatic, PLC controlled pneumatic circuits using pneumatics trainee package.
3. Study of various components in hydraulic circuits. Assembly and operation of some basic hydraulic and electro-hydraulic circuits.
4. Study the basic geometry motions of Jointed Arm Robot. Teach Pendant programming of the robot using various basic and advanced programming techniques i.e. WAIT commands etc.
5. Study the operation of Hydraulic circuit simulation software and using the same for drawing and simulating some hydraulic circuits.
6. Study the operation of pneumatic circuit simulation software and using the same for drawing and simulating some pneumatic circuits.
7. Study the basic features of a PLC. Programming of the ABB, PLC for various logic and regulated decisions.
8. Study the basic features of a programmable motion controller programming of the DC servo motion controller and its accessories for simple programs.
9. Study the operation of a Robotics simulation software and simulation of some basic robot configuration using Industry specific language.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

MEPC-314	Design of Machine Elements-II Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites:
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To study the design of various types of gears and their application
CO 2	Design a system using different components and having knowledge of simulation.

List of Experiments

1. Design of Spur gear set.
2. Design of Helical Gear set
3. Design of Worm Gears Set
4. Design of Bevel Gears Set
5. Design of springs.
6. Selection of Sliding Contact Bearings:
7. Selection of rolling Contact Bearings:
8. Design project involving multiple machine components: The project should expose the students to some aspects of system design such as selection and configuration of the machine elements involved considering different alternatives to developing a final system with dimensions using MATLAB software.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

References:

1. Mechanical Engineering Design by J.E. Shigley, C.R. Mischke & R.G. Budynas, McGraw Hill.
2. Machine elements in Mechanical Design by R.L. Mott, Prentice Hall.Mechanical Design by P. Childs, Elsevier.
3. Fundamentals of Machine Component Design by R. C. Juvinall & K. M. Marshek, Wiley.
4. RudraPratap , "Getting started with MATLAB: A quick introduction for scientists and engineers". Oxford Series.

MEPC-401	Refrigeration and Air Conditioning	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Applied Thermodynamics-I (MEPC-207), Applied Thermodynamics-II (MEPC-202).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To review thermodynamics and thermal systems engineering and develop understanding of vapor compression and heat-driven refrigeration systems.
CO 2	To understand the components of vapour compression refrigeration system.
CO 3	To develop familiarity with refrigerants from the performance and environment point of view.
CO 4	To develop understanding of the principles and practice of thermal comfort.
CO 5	To apply the basic principles of Psychometric and applied Psychometric.
CO 6	To develop an ability for design the whole system consisting of several components and subsystems

Detailed Syllabus

Basic Concept: Natural and Mechanical Refrigeration, Application of refrigeration, Units of refrigeration and Coefficient of performance, Refrigeration effect, cooling capacity and COP of a refrigerator, heating effect, heating capacity and COP as heat pump.

Bell Coleman Cycle and Aircraft Refrigeration: Bell Coleman Cycle and its analysis; optimum COP and pressure ratio, necessity of air craft refrigeration – air cycle refrigeration systems and their comparison.

Vapour Compression Refrigeration Cycle: Vapour compression cycle on P-V, P-H and T-diagrams, deviation of actual cycle from theoretical cycle, compressor capacity and volumetric efficiency, analysis of theoretical and actual vapour compression cycles, effect of suction pressure, discharge pressure, sub-cooling, super heating and pressure drop in valves on performance and cooling capacity.

Vapour Compression Refrigeration with Multiple Evaporators and Compressors: Compound compression with single and multiple expansion valves, water inter-cooling and flash inter-cooling, multiple load systems with single and multiple expansion valves.

Vapour Absorption Refrigeration Cycle: (No Mathematical Analysis) Principle of absorption system; components of the system, Desirable properties of absorption system refrigerant and absorbent, Aqua– ammonia absorption refrigeration system, Lithium Bromide–water absorption refrigeration system; Lithium Bromide–water absorption system, Comparison between absorption and compression system.

Refrigerants: Classification and nomenclature of refrigerants, Desirable thermodynamic, chemical and physical properties of refrigerants, comparative study of commonly used refrigerants and their fields of application; Azeotropes, Effect of moisture and oil miscibility, Refrigerant drying agents and antifreeze solution, leak detection and charging of refrigerants, environmental, aspects of conventional refrigerants, friendly refrigerants.

Non-Conventional Refrigeration Systems (No Mathematical Analysis): Cascade Refrigeration System, Linde and Claude cycles for liquefaction of gases.

Air Conditioning: Concept and Applications, Psychometric properties of air, Dry bulb, wet bulb and dew point temperatures; Relatives and specific humidity; degree of saturation, adiabatic saturation temperature, enthalpy of air and water vapours, psychometric chart. Human requirements of comforts, effective temperature and comfort charts, Industrial and comfort air conditioning.

Psychrometric Process: Sensible heating and cooling, cooling with dehumidification, Heating with dehumidification, by-pass factor, chemical dehumidification, adiabatic mixing, air washer. Cooling and heating load estimation

Refrigeration and Air Conditioning Equipment: Brief description of compressors, condensers and evaporators and expansion devices, Cooling towers.

Books Recommended

1. Arora C P, *"Refrigeration and Air Conditioning"*, 19th Edition, Tata McGraw Hill, Delhi (1985).
2. Pradad M, *"Refrigeration and Air Conditioning"*, 2nd Edition, New Age International Private Limited, Delhi (2002).
3. Dossat, R J, *"Principles of Refrigeration"*, 4th Edition, Pearson Education (Singapore), India, (2002).
4. Mcquiston F G, Parker J D and Spilter J D, *"Heating, Ventilating, and Air Conditioning"*, 5th Edition, John Wiley and Sons Inc, New York (2001).
5. Jordan and Priester, *"Refrigeration and Air Conditioning",* Prentice Hall of India (1998).
6. Ananthanarayan, "Basic Refrigeration and Air Conditioning",3rd Edition, Tata McGraw Hill.

MEPC-403	Vibrations and Control	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Ability to mathematical model and analyze 1- DOF: (i) undamped free and forced, damped forced, and free vibratory system,(ii) for vibration isolation (vibration control) and transmissibility.
CO 2	Ability to mathematical model and analyze 2-DOF damped and undamped free vibratory system, Understand the static, dynamic and dissipative coupling.
CO 3	Basic understanding of methods of prediction of natural frequency and mode shapes for multi degree freedom vibratory system.
CO 4	Ability to model and analyze whirling of shafts.
CO 5	Continuous System: Ability to analyze longitudinal, torsional free vibrations of circular bar, and transverse free vibration of beam.

Detailed Syllabus

Introduction: Basics of vibration, its effects, Harmonic and non-harmonic motions, kinetic and potential energy, Conservative non-conservative system in reference to vibrations.

Single Degree Freedom System: Free vibrations of systems without damping, equilibrium and energy methods, Rayleigh's method, equivalent system, systems with compound springs, shafts of different diameters, free vibrations with viscous damping, logarithmic damping, coulomb and structural damping etc., Forced vibration with viscous damping, equivalent viscous damping, impressed force due to unbalanced masses and excitation of supports, jump phenomenon, vibration isolation, Transmissibility, commercial isolators.

Two Degree Freedom Systems: Free undamped vibrations, static and dynamic coupling, principal modes of vibration dynamic vibration absorber, centrifugal absorber, and friction damper, vehicle suspension system response.

Multi degrees Freedom System: Holzer's analysis for multimass and multi inertia systems, simple geared systems; Dunkerlay's methods, Stodla method.

Whirling of shafts: Whirling and its implications, whirling of light flexible shaft with a unbalance disc at the center, uniform shaft with and without unbalance - Rayleigh's method.
Continuous System: Free longitudinal vibrations, tortional vibrations of circular shaft, and transverse vibration of beam.

Books Recommended

1. Rao S S, *"Mechanical Vibrations",* Pearson Education, Delhi (2004).
2. Roger A A, *"Fundamentals of Vibrations",* Amerind Publisher Company Private Limited, New Delhi (1999).
3. Srinivas P, *"Mechanical Vibration Analysis",* Tata McGraw Hill Company Limited, New Delhi (1990).
4. Mallik A K, *"Principles of Vibrations Control",* Affiliated East West Press Private Limited, New Delhi (2000).
5. Daniel J Inman, *"Engineering Vibration",* Prentice Hall, New Jersey (2001).

MECI-400	Major Project (Phase-I)	Core Course	L	T	P	Credit
			0	0	4	0

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Students will demonstrate the ability to discern the assignment's intended audience and objectives and respond appropriately.
CO 2	Students will demonstrate the ability to identify the disciplinary context for different kinds of writing, including both formal and informal writing.
CO 3	Students will demonstrate the ability to construct a paper consistent with expectation of the discipline, including an appropriate organization, style, voice and tone.

MEPC-405	Refrigeration and Air Conditioning Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: Applied Thermodynamics-I (MEX-207), Applied Thermodynamics-II (MEX-202).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

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

CO 1	Demonstrate knowledge and application of basic concepts and terminology.
CO 2	Demonstrate by performing experiments, the working of basic refrigeration machines such as window air conditioner, Ice Plant, Mechanical Heat Pump.
CO 3	Demonstrate knowledge and application of various controls in HVACR systems.
CO 4	Demonstrate knowledge of refrigeration and its application in troubleshooting and servicing HVACR systems.
CO 5	Demonstrate an understanding of the mathematics and science involved in the operation of HVACR systems.

List of Experiments

1. To find out the coefficient of performance of vapour compression refrigeration test rig Using (a) Capillary tube as an expansion valve. (b) Thermostatic expansion valve.
2. To find out the EPR (Energy Performance Ratio) of a Mechanical Heat Pump based on vapour compression refrigeration cycle.
3. To study the working of Electrolux vapor absorption refrigeration systems using three fluids.
4. To study the window type air conditioning test rig and performing the experiments related to basic air conditioning processes.
5. To study the ice plant test rig.
6. To study the effect of variation of brine concentration on the formation of ice.
7. To study the cut sections of reciprocating compressor of window type air conditioner.
8. To study the working of window air conditioner.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

			L	T	P	Credit
MEPC-407	**Vibrations and Control Lab***	**Core Course**	**0**	**0**	**2**	**1**

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	An ability to design and conduct experiments, as well as to analyze and interpret data.
CO 2	Assess the validity of the experimental results and compare with theoretical results when possible.
CO 3	An ability to communicate effectively by writing and submitting report.

List of Experiments

1. Determination of radius of gyration of a pendulum.
2. Determination of radius of gyration of a bar using Bi-Filar suspension.
3. Study of undamped free vibration of an equivalent spring mass system.
4. Study of forced vibrations of equivalent spring mass system.
5. Study of torsional vibrations (undamped) of single rotor shaft system.
6. Study of free vibrations of two rotor system and to determine the natural frequency of vibration theoretically and experimentally.

7. Study of damped torsional oscillations and determine the damping co-efficient.
8. Verification of Dunkerley's rule.
9. Study of forced lateral vibrations of the beam for different damping.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

MEPC-402	CAD/CAM	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To be familiar with CAD/CAM Hardware and software.
CO 2	To be familiar with types of geometric modelling and parametric representation of curves, surfaces and solids.
CO 3	Enables to select, design and use of numerical controlled technology for the manufacturing applications.

Introduction: Definitions, Historical Development. Nameable and Unnamable shapes, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.
Curves: Algebraic and Geometric Forms, Parametric space of a curve, Blending functions, Reparametrization, Truncating, Extending and subdividing, Space curve, Four point form, Straight lines, Spline Curves, Bezier Curves, B-spline Curves, Rational Polynomials, introduction to NURBS.
Geometric Transformation and Projection: Transformations: Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations. Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.

Surfaces: Algebraic and Geometric form, Tangent and Twist Vectors, Normal, Parametric space of a surface, Blending Functions, Reparametrization of a surface patch, subdividing, Sixteen Point form, Four Curve Form, Pl ane surface, Cylindrical Surface, Ruled surface, Surface of Revolution. Bezier Surface, B-Spline Surface
.
Solid Modelling Fundamentals: Topology of Closed Paths, Piecewise flat surfaces, topology of closed curved surfaces, Generalized Concept of boundary, Set theory, Boolean operators, Set-membership Classification, Euler operators, Formal Modelling Criteria.

Solid Model Construction: Graph Based methods, Boolean models, Instances and Parameterized Shapes, Cell Decomposition and spatial-Occupancy Enumeration, Sweep Representation, Constructive Solid Geometry, Boundary Representation. Assemble Modelling.
Data transfer formats: Neutral data format, IGES, STEP and XML. Applications of Solid Models: Rapid Prototyping, FEM, Medical Applications**.**

Computer Aided Manufacturing: Evolution of Computer Numerical Control, Components, Coordinate system, Working principle of CNC Lathe, Turning Centers, Milling Machine, Machining Center, Drilling Machine, Boring Machine.

Books Recommended

1. Michael E. Mortenson, "*Geometric Modelling*", John Wiley, 2006
2. Roger and Adams, "*Mathematical Elements of Computer Graphics*", McGraw Hill, 1994.
3. Groover and Zimmers, *"CAD / CAM: Computer Aided Design and Manufacturing",* Prentice Hall of India, New Delhi (1994).
4. Ramamurthi V, *"Computer Aided Mechanical Design and Analysis",* Tata McGraw Hill Publishing Co Ltd (1998).
5. Ibrahim Zeid, *"CAD - CAM Theory and Practice"*, Tata McGraw Hill Publishing Co. Ltd (1991).
6. Steave Krar and Arthur Gill, *"CNC Technology and Programming"*, McGraw-Hill Publishing Company (1990).
7. Radhakrishnan P, Subramanyam S, Raju V ,*"CAD/ CAM/CIM"*, New Age International Publishers (2000).

MECI-400	Major Project (Phase-II)	Core Course	L	T	P	Credit
			0	0	8	4

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Ability to demonstrate understanding of a broad range of subjects.
CO 2	Ability to analyze problems and model appropriate solutions.
CO 3	Ability to organize and manage information and knowledge.
CO 4	Ability to interact effectively with peers and superiors.
CO 5	Ability to understand the financial aspect of a solution.
CO 6	Ability to demonstrate behaviors that are consistent with the code of professional ethics and responsibilities.

MEPC-404	CAD/CAM Lab*	Core Course	L	T	P	Credit
			0	0	2	1

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Design a part or assembly of parts using Computer-Aided Design software.
CO 2	Use motion and interference checking to ensure that parts will not interfere throughout their complete range of motion.
CO 3	Use CAD software collaboratively when designing on a team.
CO 4	Communicate effectively the geometry and intent of design features.

Developed the MATLAB/ C code for the following:

Expt 1. Design of Simple curves
Expt 2. Design of Hermite curves
Expt 3. Design of Bezier curves
Expt 4. Design of B-Spline curves
Expt 5. Geometric transformation on curves.

Expt 6. Design of Bi-cubic Surfaces
Expt 7. Design of Bezier surfaces
Expt 8. Design of B-Spline Surfaces of surfaces.
Expt 9. Transformations and projection of surfaces.
Expt 10. Part-programming on CNC machines
Expt 11. Execution of part programme for machining given profile.
Expt 12. Design of Solid Modeling of a part or assembly of parts using Computer-Aided Design software.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

Books Recommended

1. RudraPratap ,"Getting started with MATLAB: A quick introduction for scientists and engineers". Oxford Series.
2. Michael E. Mortenson, "Geometric Modelling", John Wiley, 2006
3. Roger and Adams, "Mathematical Elements of Computer Graphics", McGraw Hill, 1994.
4. Groover and Zimmers, "CAD / CAM: Computer Aided Design and Manufacturing", Prentice Hall of India, New Delhi (1994).

Syllabi of Department Electives for 3rd Year

MEPE-301	Alternative Fuels for IC Engines	Department Elective	L	T	P	Credit
			3	0	0	3

CO1	Interpret and distinguish between the different types of conventional and non-conventional fuels
CO2	Demonstrate the utilization of synthetic and substitute fuels for practical applications
CO3	Describe various parameters that are utilized to characterize alternative fuels and its combustion process
CO4	Solve renewable energy related problems with knowledge in fossil fuels and alternative fuels
CO5	Demonstrate knowledge in production methods of different alternative fuels
CO6	Select from different alternative fuels available for specific potential applications
CO7	Understand the socio-economic, environmental impacts, limitations and applications of alternative fuels.

Hydrocarbon fuels: Crude petroleum oil and its refining, products of refining, availability of hydrocarbon fuels and their impact on environment.

Gasoline: Chemical composition, combustion characteristics of gasoline, Effect of various engine parameters on the combustion of gasoline; Knocking, Octane number, Effect of sulphur, ash forming additives, oxygenates, olefins, aromatics, benzene content.

Diesel: Chemical composition, combustion characteristics of diesel, Engine parameters affecting the combustion of diesel, Cetane number, sulphur content, density, volatility, distillation characteristics.

Ethanol and Methanol: Benefits of using ethanol, methanol as fuel, their method of production, properties of ethanol, methanol, methods of using ethanol, methanol in diesel engines: Fumigation, solutions, Spark injection, dual injection, ignition improvers, surface ignition, low heat rejection.

Biodiesel: Definition, advantages of biodiesels, methods of producing biodiesels; blending, cracking, Trans esterification, super critical methanol Trans esterification, properties of biodiesels, emission characteristics of biodiesels.

Gaseous Fuels: LPG, LNG and CNG Composition, combustion characteristics, dispensing methods, emission studies. Hydrogen, its combustion characteristics, flashback control technique, safety aspects and system development.Biogas, producer gas, their method of preparation, their use as an engine fuel.

Books Recommended:

1. Biodiesel, *Basics and Beyond* New Society Pub 2006
2. McGowan, Thomas *Biomass and Alternate Fuel Systems: An Engineering and Economic Guide* Wiley-AIChE 2009
3. Processing and Testing of Biodiesel Fuels Serials Publications 2009

MEPE-302	Flexible Manufacturing System	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To make students aware of new trends in manufacturing such as job shop, mass production systems and most importantly flexible manufacturing systems (FMS).
CO 2	To describe material handling systems and processing systems utilized in FMS.
CO 3	To provide fundamental knowledge of computer assisted programming language and programming languages.
CO 4	To stipulate a proper software and database for the FMS.

Detailed Syllabus

Review of Computer Aided Design and Drafting (CADD): The design processes, advantages and applications of CAD, computer hardware system, computer programming languages, model storage and data structure, CADD software packages – AutoCAD, orthographic projections.

CAD/CAM Interface and Product Design: Rationale for CAD/CAM, Computer-Aided Manufacturing, Elements of CAM Systems, NC in CAM, Product Design and Development.

Machine Tool Control: Elements of the NC Systems, Types of Control Systems, NC Part Programming, Computer Aided Part Programming, Machining Centers.

Manufacturing Systems and Automation: Trends in Manufacturing Systems, system Defined, Classification of Manufacturing Systems, Leveling and balancing the manufacturing Systems.

Robotics and Automated Guided Vehicles: Definition Robotics, Terminology, Types of Robots, basic robot motion and their control, robot programming, Automated Guided Vehicles. Typical applications in manufacturing like in welding, assembly, material handling, spray painting etc.

Group Technology (G T): Part families, parts classification, machine group/cell, cad/cam and GT, applications.

Flexible Manufacturing Systems and Computer Integrated Manufacturing Systems: (FMS) (CIMS): Components of FMS, components of CIMS, applications. Hardware and software pertaining to FMS installations.\

Books Recommended

1. Rao P N, Tewari N K and Kundra T K, *"Computer Aided Manufacturing"*, Tata McGraw
2. Hill Publishing Company Limited, New Delhi (1993).
3. Rehg J A, *"Introduction to Robotics – A System Approach"*, Prentice Hall International, Englewood Cliffs, New Jerrey (1985).
4. Tercholz E, *"CAD/CAM Handbook"*, McGraw Hill, New York (1984).

5. Malcolm D R Jr, *"Robotics: An Introduction"*, Delmar Publishers Inc (1988).
6. McMahon C and Browne J, *"CAD CAM: From Principles to Practice",* Addison – Wesley Publishing Company, New York (1993).

MEPE-303	Lubrication and Wear	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Fluid Mechanics-I and II (MEX-212; MEX-302)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Be familiar with the adhesion theories and effect of adhesion on friction and wear.
CO 2	Have a knowledge of surface topography and know how to model a rough engineering surface.
CO 3	Have a knowledge of friction/lubrication mechanisms and know how to apply them to the practical engineering problem.

Detailed Syllabus

Introduction: Tribological consideration, Nature of Surfaces and their contact; physicomechanical properties of surface layer, Geometrical properties of surfaces, method of studying surface, contact of smooth surface, contact of rough surfaces.

Friction and Wear: Role of friction laws of static friction, Causes of friction, Adhesion theory, Laws of rolling friction, friction of metals and non-metals, friction measurement. Definition of wear, mechanism of wear, factors effecting wear, wear measurement, wear of metals andnonmetals.

Lubrication and Lubricants: Introduction, dry friction, Boundary lubrication, hydrostatic and elasto hydrodynamic lubrication.

Functions of lubricants: Types of lubricants and their industrial uses, Properties of liquid and grease lubrications. Lubricant additives, general properties and selection.

Special Topics: Bearing design, selection of bearings and lubrications, Bearing maintenance, diagnostic maintenance of tribological components.

Books Recommended

1. O'Conner and Boyel, *"Standard Handbook of Lubrication Engineering",* McGraw Hill Company, New York (1968).
2. Bharat Bhushan, *"Principles and Applications of Tribology",* 1st edition, Wiley-Interscience (1999).
3. Raymond O Gunther, *"Lubrication",* Bailey Bros and Swinten Limited (1971).
4. Rowe William Brian, *"Hydrostatic and Hybrid Bearing Design",* Butter worth-Heinemann(1983).
5. Barwell P T, *"Bearing Systems, Principles and Practice",* 1st Edition, Oxford University Press, New York (1980).

MEPE-304	Mechanics of Composite Material	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Ability to analyze: anisotropic material for stress-strain i.e., to determine stiffness and compliance matrix, Macro mechanics of continuous fiber-reinforced lamina, and Multi axial theory of failure for fiber reinforced composite materials, understand the classical lamination theory, A-B-D matrix and design laminated composite structure economically thereafter.
CO 2	An ability to analyze FRP using micromechanical methods such as mechanics of material, semi empirical, and elasticity approach.
CO 3	Basic understanding of: Modeling of Discontinuous fiber reinforced composites, Hygrothermal analysis of composite lamina and laminates, and Viscoelastic behavior of fiber reinforced composites.
CO 4	Study of mechanical testing of the constituent and the elastic moduli, viscoelastic and dynamic properties of composites.
CO 5	Enable the students to independently analyze and extend a given course subject, compose a report paper and effectively communicate the essentials through an oral presentation.

Detailed Syllabus

Introduction: Basic concepts and definitions, constituent materials, applications and fabrication process related to composite materials.

Macromechanics: Lamina stress-strain relation, anistropic behaviour, engineering contents, stiffness and compliance matrices, transformed matrices and invariants. Analysis of laminates, classification of laminates, laminated beams. Laminated plates, theory of laminated plates with coupling, stiffness characteristics of related laminates, laminate compliances, lamina and laminate stresses and strains, and laminate engineering constants.Introduction to interlaminar stresses, laminate strength and failure analysis.

Micromechanics: Continuous fiber-reinforced lamina, prediction of elastic moduli by mechanics of material, elasticity and semi-empirical models and model for prediction of lamina strength. Discontinuous fiber-reinforced lamina, elastic moduli and stress-strain relationship.

Mechanical Testing: Measurement of constituents i.e., fiber and matrix, measurement of elastic moduli, viscoelastic and dynamic properties of composites.

Books Recommended

1. Jones R M, *"Mechanics of Composite Materials",* Scripta Book Company (1975).
2. Herkovic C T, *"Mechanics of Fibres Composites",* University of Virginia, John Wiley andSons, Inc (1998).
3. Tsai Stephen W, *"Introduction to Composite Materials"*, Technomic Publishing CompanyInc (1980).
4. Gibson R F, *"Principles of Composites Materials Mechanics"*, McGraw Hill InternationalEdition, New York (1994).

5. Hyer M W, *"Stress analysis of Fiber-Reinforced Composites Materials"*, WCB McGraw Hill, Boston (1997).

MEPE-305	Occupational Safety and Environment	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Develop a broad base knowledge in science. Apply knowledge to anticipate, recognize, and quantify agents, factors, and stressors generated by and/or associated with defined sources, unit operations, environmental processes, & work tasks.
CO 2	Develop an ability to analyse, evaluate, management systems and programs to prevent hazardous acts and conditions that lead to loss events. The programs will include cost/benefit analysis, training programs, etc.; Develop and evaluate appropriate strategies designed to mitigate risk.
CO 3	Evaluate and recommend engineering, administrative, and personal protective equipment controls or other interventions to reduce or eliminate hazards; Recognize important professional, ethical, social, cultural, global, and current issues impacting worker health and the environment.
CO 4	Interpret and apply current applicable occupational and environmental regulations; Participate as a team player in the development of scientific reports, and technical summaries; Effectively communicate verbally and in writing using computers and state of the art media; and Recognize the importance of continuous and ongoing learning.

Detailed Syllabus

Safety: Meaning & need for safety. Relationship of safety with plant design, equipment design and work environment. Industrial accidents, their nature, types and causes.ssessment of accident costs; prevention of accidents. Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis.Safety and economics, safety and productivity.Employees participation in safety. Safety legislation.

Environment: Environmental factors in industry. Effect of temperature, Illumination, humidity noise and vibrations on human body and mind.Physiology of heat regulation.Thermal environment and its measurement.Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation.Mechanical ventilation.Air conditioning Process ventilation. Control of heat exposures, control at source, insulation, and local exhaust ventilation. Control of radiant heat, dilution ventilation.Local relief.

Industrial Lighting: Purpose of lighting, benefits of good illumination. Phenomenon of lighting and safety.Lighting and the work.Sources and types of artificial lighting.Principles of good illumination.Recommended optimum standards of illumination.Design of lighting installation.

Noise and Vibrations: Continuous and impulse noise. The effect of noise on man.Noise measurement and evaluation of noise.Noise isolation.Noise absorption techniques. Silencers

vibrations: Effect, measurement and control measures. Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work.

Books Recommended

1. Krishnan N V, *"Safety management in Industry"*, Jaico Publishing House, Delhi (1993).
2. Kocurek Dianna and Woodside Gayle, *"Environment, Safety, and Health Engineering"*, John Wiley and Sons, New York (1997).
3. McCormick J, *"Human Factors in Engineering and Design"*, Tata McGraw Hill Publishing Company Limited, New Delhi (1979).
4. Willie Hammer, Dennis Price, "Occupational Safety Management and Engineering", 5th Ed., Pearson Education (2000).
5. David Goetsch, "The Safety and Health Handbook", Pearson Education (1999).

MEPE-306	Operation Management	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Analysis of System concepts: Classification of systems Organizations as systems.
CO 2	Definition, objectives, functions and scope of operations management.
CO 3	Industrial management – relationship of operations management with the areas of industrial management.
CO 4	Types of productive systems and their characteristic features – Continuous and intermittent systems.
CO 5	Decision making in production systems: Scientific process Characteristics of decisions Framework for decision making.

Detailed Syllabus

Operations Management: Introduction, Historical Evolution of Production and Operations Management, Trends in Operation Management, Production and Operations management as a Career, Operation strategies for competitive advantages, Productivity and Quality, Technology and Mechanization.

Production Planning and Control: Forecasting, Capacity Planning, Layout Planning, Location Analysis, Plant Layout and Materials Handling.
Product Design and Development: Steps involved in Product design and development, Factors affecting Project Design and Development like ergonomics, aesthetic, economic, technical. Case studies.

Materials Management and Inventory Control: Inventory concepts, Scope, function and objectives of Inventory, Inventory costs, Determination of E.O.Q., ERP, MRP-I, MRP-II, Just in time, Concept of Zero Inventory.

Quality Control: Meaning of Quality Control and its Impact, Functions of Quality Control, Introduction to SQC, Japanese Contribution to Quality Control, Managing Quality, Introductory Concept of Six Sigma, Introduction to ISO 9000 and 14000, Specific Case Studies.

MIS: Introduction to Management Information system, Steps involved in designing an MIS, Role and Application of Computers in MIS, Case studies.
Project Management: Project planning, Project scheduling models, Managing the project, Work breakdown structure, Progress reporting, Role of Human Behavior in project environment.

Books Recommended

1. Buffa and Sarin, *"Modern Production / Operation Management",* 8th Edition, John Wiley and Sons (1987).
1. Adam and Ebert, *"Production and Operations Management",* 5th Edition, Prentice Hall of India, New Delhi (2000).
2. Krajenski and Ritzman, *"Operations Management Strategy and Analysis'',* 6th Edition, Pearson Education, New Delhi (2002).
3. Mazda Fraidoon, *"Engineering Management",* 3rd Reprint, Pearson Education (2000).
4. Besterfiled, *"Total Quality Management",* Pearson Education (2003).

MEPE-307	Operations Research	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Illustrate the need to optimally utilize the resources in various types of industries.
CO 2	Apply and analyze mathematical optimization functions to various applications.
CO 3	Demonstrate cost effective strategies in various applications in industry.

Detailed Syllabus

Overview: Introduction**,** Definition, characteristics and scope of O.R., Objectives of O.R., Phases and models in O.R.

Linear Programming: Introduction, Concept of linear programming, Graphical method, Simplex method, Big M method, Dual simplex method, Two-phase method, Duality in linear programming.

Transportation Problem: Introduction, Mathematical models for T.P., Formulation and solution of balanced and unbalanced T.P., Trans shipment models.

Assignment Models: Definition, Comparison with transportation model, Mathematical representation of assignment models, Formulation and solution of assignment models, Variations of the assignment problem and alternate optimal solutions.

Sequencing Models: Processing n jobs through two machines, processing n jobs through three machines, processing two jobs through m machines, processing n jobs through m machines, Travelling salesman problem.

Inventory Control: Purchase model with instantaneous replenishment and with and without shortages, Manufacturing model with and without shortages, Quantity discount.
Queueing Theory: Introduction, Terminologies of queueing system, Empirical queueing models.

Replacement Models: Replacement of items that deteriorate with time, Replacement of items that fail suddenly, Individual and group replacement.

Game Theory: Introduction and terminologies of game theory, games with pure and mixed strategies.

CPM and PERT: Basics steps in PERT and CPM, PERT and CPM computations, Cost analysis, Contracting and Updating, Resource Scheduling.

Books Recommended:

1. Panneerselvam R, "*Operations Research*", PHI, 2002.
2. Tulsian P.C., Pandey Vishal, "*Quantitative Techniques*", Pearson Education, 2002.
3. Wagner, "*Principles of Operations Research*", Prentice-Hall India, 2000.

MEPE-308	Power Plant Engineering	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To be familiar with basics of power plant and functioning of thermal, gas turbine and hydro power plant along with various components and their functions.
CO 2	To be able to analyze different types of steam cycles and operating procedure of thermal power plant as well as estimate efficiencies in a steam power plant.
CO 3	To be familiar with basic working principles of gas turbine and hydro power plant and define the performance characteristics and components of such power plants.
CO 4	To be familiar with types, principles of operations and applications of steam turbines, steam generators, condensers, feed water and circulating water systems.
CO 5	To be able to define terms and factors associated with power plant economics. Estimate the cost of producing power per kW.

Detailed Syllabus

Introduction: Power plant, classification, steam power plant, gas turbine, based, I C Engine based, nuclear power based, hydropower.

Steam Power Plant: Components of steam power plant, carnot cycle, Rankine cycle, Different methods to improve the efficiency of steam power plant, regeneration, reheating of

steam, regenerative feed water heating. Supercritical pressure cycle, cogeneration of power and process heat.

Combined cycle power generation: Binary vapour cycles, coupled cycles, gas turbine – steam turbine power plant, MHD – Steam power plant, thermionic steam power plant. Fuels and Combustion: Various types of fuels, coal, fuel oil, natural and petroleum gas, synthetic fuels, biomass, combustion process, combustion equipments like cyclone furnace, fluidized bed combustion.

Steam Generators: Classification, fire tube boiler, water-tube boilers, economizers, super heaters, air prehater, deaeraton, boiler blowdown, air handling system, electrostatic precipitators.

Steam Turbines: Types of turbines, Impulse and Reaction, compounding in turbine, pressure, velocity compounding.

Condensers: Direct contact condensers, surface condensers, cooling towers, cooling tower calculations.

Gas Turbine Power Plant: Components of gas turbine based power plant, open cycle and closed cycle, methods to increase the efficiency of gas turbine plant like intercooling, reheating and regeneration.

Hydro Power Plant: Classification of water turbines, construction and working of Pelton Francis and Kaplan turbines.

Economics of Power Generation: Load duration curves, power plant economics, location, Indian energy scenario.

Books Recommended

1. Wiesman J and Eckart R, *"Modern Power Plant Engineering"*, Prentice Hall,New Delhi (1985).
2. Nag P K, *"Power Plant Engineering",* Tata McGraw Hill,New Delhi (1998).
3. Kostyuk.A and Frolov V, *"Steam and Gas Turbines",* Mir Publishers, Moscow (1988).
4. Aschner F S, *"Planning Fundamentals of Thermal Power Plants",* John Wiley (1978).
5. Eastop T D and McConkey, *"Applied Thermodynamics",* Longman Scientific and Technical (1986).

MEPE-309	Product Design and Development	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Design of Machine Elements (MEX-301).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Understand the product design and development process, product planning and concept generation.
CO 2	Understand the Design for Manufacturing, prototyping and Robust Design and product architecture

Detailed Syllabus

Introduction-Introduction to product design, Significance of product design, product design and development process, sequential Engineering design method, the challenges of product development, Development Process and Organizations-Generic Development Process, Concept Development, Adapting the generic PD process flows, AMF development Process, Product Development Organizations, The AMF Organization.

Product Planning and Identifying Customer Needs-Product Planning process, Interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance of needs, review of the process. Product Specifications-Establish target specifications, setting final specifications.

Concept Generation-Activities of concept generation, clarifying problem, search both internally and externally, explore the output,

Concept Selection-Overview, concept screening and concept scoring, methods of selection.

Concept Testing-Elements of testing: qualitative and quantitative methods including survey, measurement of customers' response.

Product Architecture-Modular & Integral architecture, implications, establishing the architecture, Delayed differentiation, Platform Planning.

Industrial Design-Assessing need for industrial design, Impact of industrial Design, Industrial design process, management of industrial design process, assessing quality of industrial design.

Embodiment Design: Design for Manufacturing, prototyping. Robust Design. Intellectual Property and Environmental Guidelines-Intellectual Property: Elements and outline, patenting procedures, claim procedure, Environmental regulations from government, ISO system.

Books Recommended:

1. Ulrich K. T, and Eppinger S. D, Product Design and Development, Tata McGraw Hill
2. Otto K, and Wood K, Product Design, Pearson
3. Engineering of creativity: introduction to TRIZ methodology of inventive Problem Solving, By Semyon D. Savransky, CRC Press

MEPE-310	Production Management	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understand the core features of the operations and production management function at the operational and strategic levels specifically the relationships between people, process, technology, productivity and quality improve an organizations performance.

CO 2	Develop an integrated framework for strategic thinking and decision making to analyze the enterprise as a whole with a specific focus on the wealth creation processes.
CO 3	Able to communicate effectively through discussion in seminars, teamwork and writing in discussion board, and a project report by gather evidence, data and information to make decisions.
CO 4	Utilize Tools viz. Value analysis, TPM and their contribution towards current production and operations management.

Detailed Syllabus

Introduction: Definition and scope of industrial engineering, Role of industrial engineer in industry. Qualities of an Industrial Engineer.

Work Study: Productivity and the standard of living, reducing work content and ineffective time, the human factor in the application of work-study, Working conditions and the working environment.

Method Study: Introduction of method study and the selection of jobs, Methods and movements at the workplace.

Work Measurement: Introduction, Work sampling, Time Study, equipment, timing the job, rating, Calculation of standard time, Setting time standard for works and machines, Predetermined time standards, Standard data and its use. Specific case studies.

Value Engineering: Types and concept of value engineering, phases of value engineering studies, application of value engineering.

Job Design: Traditional engineering dimensions of job design, Concepts of job enlargement, Job enrichment, Job rotation, effective job design in relation to technological and behaviour factors.

Ergonomics: Introduction, Considerations in designing man machine systems with special reference to the design of displays and control.

Maintenance Management: Introduction, types, total productive maintenance, condition monitoring.

Books Recommended

1. Barnes M R, "*Motion and Time Study*", John Wiley and Sons (2002).
2. Oborne D J, *"Ergonomics at Work",* John Wiley and Sons (1985).
3. Miles, *"Techniques of Value Analysis and Engineering",* 2nd Edition, McGraw Hill (1997).
4. Ulrich Cart T and Eppinger Steven D, *"Product Design and Development",* Tata McGraw Hill, New Delhi (1995).
5. Hicks, *"Industrial Engineering and Management",* 2nd Edition, Tata McGraw Hill, New Delhi (1994).

MEPE-311	Production Planning and Control	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Apply the systems concept for the design of production and service systems
CO 2	Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
CO 3	Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources

Detailed Syllabus

Introduction: Definition of PPC, Concept of production planning and production control, objectives and functions of PPC, Comparison among production planning and production control, Information requirement for PPC, Manufacturing methods and PPC, Problems of PPC.

Function of PPC: Routing: concept, procedure, route sheet, routing in job order, Scheduling: objectives, factors affecting scheduling, master scheduling, production, Machine loading: objectives, adjustments, Dispatching: centralized and decentralized dispatching, Production Control: concept, objectives, progress reporting, correction actions, Types of Production Systems.

Forecasting Techniques: Concept and purpose of sales forecasting and production volume forecasting, Market Potential, Basic elements, Delphi methods, Moving average technique, Correlation analysis, linear regression analysis, Forecast error, Costs and accuracy of Forecasts.

Materials Management: Objectives, functions and types of materials management, organization and economic aspects of materials management, Buying Techniques, Purchasing Procedures and methods, inventory control, Economic Order Quantity, Inventory models, MRP: terminology, system, output, and logic, Break even analysis, Vendor rating, Outsourcing.

Process Planning: Framework for Process Engineering, Process and equipment selection, machine requirements, Machine outputs, Manpower planning, Combined Operations, Computer Aided Process Planning, Problems.

Supporting PPC Activities: Group Technology: group layout, stages, benefits and problems, Lean Manufacturing, Agile manufacturing, JIT, Supply Chain Management, Role of Database Management System in PPC, Lean Manufacturing, Enterprise Resource Planning.

Books Recommended:

1. Production Planning and Control: Samuel Eilon
2. Production and Operations Management: Adam Ebert
3. Production Planning & Inventory Control: Narsimhan

MEPE-312	System Dynamics & Control	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understanding the concept of physical systems in multi-energy domains and modeling their dynamics through the unified approach of Bond graph.
CO 2	Understanding the concept of causality and its implications for deriving system equations from bond graph models.
CO 3	Understanding and applying principles of classical and modern control theory to the control of multi-energy physical systems.
CO 4	Ability to simulate models of multi-energy physical systems and analyse their response through case studies.

Detailed Syllabus

Introduction to Physical System Dynamics

Modeling of Physical System Dynamics: A Unified Approach: Physical systems, Introduction to Bond graphs, Ports, Bonds and Power; Elements of Bond graphs, 1-port elements – resistor R, Stiffness C, and Inertia I, Source of Effort Se and Flow Sf; 2-port elements – Transformer TF and Gyrator GY, with modulation, Junction elements 1 and 0; Causality: Causality for basic 1-port and multi-ports. Derivation of System equations from Bond graphs in first order state space form.

Bond graph modeling of multi-energy systems:
Mechanical Systems, Translation and rotation (about a fixed axis), Electrical Systems, Electromechanical Systems, Fluid systems, Transducer models – cylinder, rack and pinion, electromechanical transducers - motors, pumps – positive displacement and centrifugal pump, gear trains, etc.

Analysis of linear systems:
Free and forced response for first and second order systems, Undamped and damped oscillator, Derivation of Signal flow graphs from Bond graphs, Derivation of Transfer functions, Bode plots

State variable analysis:
State transition matrix, Characteristic equation, Eigen values and Eigen vectors, Their impact on system response, Similarity transformations and their properties, Controllability and Observability, Canonical forms: Controllable, Observable, Diagonal.

Stability Criteria:
Routh-Hurwitz criterion, Liapunov stability criteria.

Controllers:
Pole-placement method, Proportional Integral and Derivative feedback.

Simulation and case studies: Computer simulation of Dynamic Systems using Bond graphs.

Books Recommended

1. Karnopp, Margolis, Rosenberg, System Dynamics: *Modeling and Simulation of Mechatronic Systems*, Fourth Edition, Wiley (Higher education), 2005.
2. Karnopp, Margolis & Rosenberg, *System Dynamics: A Unified Approach*, Wiley, 1990.
3. Amalendu Mukherjee & R. Karmakar, *Modeling & Simulation of Engineering Systems through Bond Graphs*, Narosa, 2000.
4. Amalendu Mukherjee, Ranjit Karmakar and Arun Kumar Samantaray, *Bond Graph in Modeling, Simulation and Fault Identification*, I. K. International Publishing House Pvt. Ltd, 2006.
5. Eronini Umez-Eronini, *System Dynamics & Control*, Brooks/ Cole Publishing Company, 1999.
6. B. C. Kuo, *Feedback Control Systems*, Prentice Hall.
7. K. Ogata, *Modern Control Engineering*, Prentice Hall.
8. Bernard Friedland, *Control Systems Design*, McGraw-Hill.

MEPE-313	Total Quality Management	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Select and apply appropriate techniques in identifying customer needs, as well as the quality impact that will be used as inputs in TQM methodologies.
CO 2	Measure the cost of poor quality and process effectiveness and efficiency to track performance quality and to identify areas for improvement.
CO 3	Understand proven methodologies to enhance management processes, such as benchmarking and business process reengineering.
CO 4	Choose a framework to evaluate the performance excellence of an organization, and determine the set of performance indicators that will align people with the objectives of the organization.

Detailed Syllabus

Quality and Total Quality Management: Excellence in manufacturing/services, factors of excellence, and relevance of TQM.

Concept and definition of quality: Total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM.

Just-in-Time (JIT): Definition: Elements, benefits, equipment layout for JIT system, Kanban system, MRP (Material Requirement Planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT, cause and effect chain, JIT implementation.

Customer: Satisfaction, data collection and complain, redressal mechanisms.

Process Management: Factors affecting process management, Quality function deployment

(QFD), Quality Assurance System.

Total Employees Involvement: Empowering employees: Team building; quality circles, Reward and Recognition; Education and Training, Suggestion schemes.

Problem solving: Defining problem, problem identification and solving process, QC tools.

Benchmarking: Definition, concept, process and types of benchmarking.

Quality Systems: Concept of quality system standards, Relevance and origin of ISO 9000, Benefits, Elements of ISO 9001, ISO 9002, ISO 9003.

Books Recommended

1. Besterfield and Besterfield, *"Total Quality Management",* 2nd Edition, Pearson Education
1. (Singapore) P Ltd, India (2001).
2. Sunder Raju, *"Total Quality Management A Primer",* 3rd Edition, Tata McGraw Hill, Delhi (2001).
3. Zairi M, *"Total Quality Management for Engineers",* 2nd Edition, Aditya Books, Delhi, (1995).
4. Hradesky J L, *"Total Quality Management Handbook",* McGraw Hill (1994).
5. Dalela S and Saurabh, *"A manual of ISO 9000 Quality System",* 2nd Edition, S Chand & Company Ltd, Delhi (1999).

Syllabi of Department Electives for 4th Year

MEPE-401	Automobile Engineering	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Develop chassis and identify suitable engine for different applications and formulate steering, braking and suspension systems.
CO 2	Select a suitable conventional and automatic transmission system.
CO 3	Identify the usage of electrical and hybrid vehicles.
CO 4	Use of ANSYS software.

Detailed Syllabus

Introduction to Automobile: Importance, applications, job opportunities, classification, types of vehicles, Basic structure, general layout, hybrid vehicles.

Automotive Electric and Electronic Systems: Electric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles.

Automotive Drive Trains: Clutches, manual and automotive transmission and transaxles, drive shafts, universal joints, drive axles.

Automotive Chassis: Suspension system, steering system, wheel alignment, brakes, wheels and tyres.

Maintenance and Trouble Shooting: Automobile performance, drivability, emissions and emission norms, noise and vibration, engine tuning, equipment for measuring various vehicle parameters such as bhp, a/f ratio, noise, vibration and emission, comfort and safety.

Recent advances in automobiles and automotive components.

Books Recommended

1. Crouse W H and Anglin D N, *"Automotive Mechanics",* McGraw Hill, 10th Edition, Singapore (1993).
2. Bosch, *"Automotive Handbook",* SAE Publication (2000).
3. Tom Denton, *"Automobile Electrical and Electronics Systems",* Butterworth-Heinemann (2003).
4. Layne Ken, *"Automotive Engine Performance: Tune up, Testing and Service",* Englewood Prentice Hall of India (1986).
5. Tom Denton, *"Advanced Automobile Fault Diagnosis",* Butterworth-Heinemann (2002).

MEPE-402	Combustion Generated Pollution and Control	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Understand the fundamental knowledge of thermodynamics and chemical kinetics of combustion
CO2	Apply the general principles of combustion of fuels
CO3	Explain the formation mechanisms of combustion-generated air pollutants
CO4	Understand and select appropriate methods for air pollution measurement and control
CO5	Determine the air pollutant concentration and dispersion from sources.

Detailed Syllabus

Generation and nature of pollutants from various combustion sources, their effects on health and the environment.Emission indices.Thermo-chemistry of pollutant formation, stoichiometry, chemical thermodynamics, kinetics.Pollutants from I.C. engines, power plants, domestic and other sources.Meteorology and dispersion of pollutants, instruments for pollutant measurement and monitoring.Legislation and emission standards.

Books Recommended

1. Edward f. Obert, Internal Combustion Engine and air pollution, Intent Education publishers.
2. John B.Heywood, Internal Combuston Engine Fundamentals, Mc Graw Hill Book, 1988.
3. Crouse William, Automotive Emission Control, Gragg Division/Mc Graw Hill, 1980.
4. Ernst S.Starkman, Combustion Generated air pollution, Plenum Press.
1. George Springer and Donald J.Patterson, Engine Emissions, Pollutant formation and measurement, Plenum press.
5. Obert.E F, IC Engines and air pollution, Intent Education publishers.

MEPE-403	Computational Fluid Dynamics	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To enable the students to understand different problem solving techniques theoretically and appreciate the importance of mathematics in engineering problem solutions.
CO 2	To illustrate different techniques to solve continuous formulations in differential form and transform them to discrete formulations using different discretization techniques like, FDM, FEM and FVM.
CO 3	To make students understand that FVM is most appropriate technique for developing discrete formulations and discuss the same technique in detail.
CO 4	To make students aware of different algorithms to solve numerically the fluid dynamics problems.
CO 5	To make students understand the utility of using commercial codes like, FLUENT and CFX and compare the competence of these codes with the dedicated codes written for engineering problems.

Detailed Syllabus

Review of basic fluid mechanics and the governing Navier-Stokes equations, Techniques for solution of PDEs – finite difference method, finite element method and finite volume method, Finite volume (FV) method in one-dimension, Differencing schemes, Steady and unsteady calculations, Boundary conditions, FV discretization in two and three dimensions, Simple algorithm and flow field calculations, variants of SIMPLE, Turbulence and turbulence modeling, illustrative flow computations, Commercial softwares such as FLUENT and CFX – grid generation, flow prediction and post-processing.

Books Recommended:

1. S V Patankar, *Numerical Heat Transfer and Fluid Flow*, McGraw Hill, NY, (2005).
2. John Anderson, *Computational Fluid Dynamics*, McGraw-Hill Publication, 1st edition (February 1, 1995).
3. W M Kays and M E Crawford, *Convective Heat and Mass Transfer*, McGraw Hill, New York (1993).
4. F M White, *Viscous Fluid Flow* by, Mc-Graw Hill, New York, 2nd Ed. (1991).
5. Robert Siegel and John Howell, *Thermal radiation Heat Transfer*, 4th Ed., Taylor and Francis NY, (2002).

MEPE-404	Control Theory and Applications	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Learn the basics of control systems and understand how to build the transfer functions of simple mechanical systems.
CO2	Understand the design of various controllers such as PID controller and predict the response of simple systems
CO3	Understand about gain and phase margin. Learn the concept of active vibration control
CO4	Design various mechanical systems and predicts its behavior by plotting root locus diagram
CO5	Learn and apply the state space model to simple systems. Design and solve few problems by using digital control system

Detailed Syllabus

Introduction to automatic controls. Modeling of flow, heat transfer and electrical, pneumatic and vibration systems. Block diagram and transfer function. Modeling of continuous systems.Extraction of reduced order models. Transient and frequency response evaluation using Laplace transform. Characteristics of hydraulic controller, pneumatic, electronic controller, electro-hydraulic and electro-pneumatic controllers.PID control.Stability.Gain and phase margins. Control system design using root and compensation. Application to Machine tool, Boiler, Engine Governing, Aerospace, Active vibration control, etc.Auto-tuning.Sequence control, Logic diagram.Introduction to digital control, Implementation using computer.Introduction to control of MIMO systems. State Space modeling. Tutorials for control problems in these areas using MATLAB.

Books Recommended:

1. Gopal M, "*Modern Control System Theory*", John Wiley & Sons (16 May 1984)
2. Gopal M and Nagrath I.J, "*Control Systems Engineering*", New age international publishers (2007)
3. Ogata K, "*Modern Control Engineering (5th Edition)*", Prentice Hall International UK London (1997)

MEPE-405	Cryogenics	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Refrigeration and Air Conditioning (MEX-401)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Describe various methods to produce low temperature and phenomena's at cryogenic temperature.
CO 2	Understand the working principle of different cryogenic refrigeration and liquification system.
CO 3	Understand the functions and working principles and various low temperature measuring and storing device.

Detailed Syllabus

Introduction: Historical review, application areas, properties of cryogenic fluids.

Cryogenic Liquefaction System: Refrigeration and liquefaction cycles, ideal cycle, actual liquefaction cycles.
Cryogenic Refrigeration Systems: Joule Thompson, striling, Gifford – McMahon, magnetic refrigeration system.

Air Separation System: Linde and Claude system for air liquefaction.

Components of cryogenic systems: Heat exchanges, expanders, compressors, storage dewars and transfer lines.

Books Recommended

1. Barron R F, *"Cryogenic Systems",* Oxford (1983).
2. Jacobsen T R, *"Thermodynamics Properties of Cryogenic Fluids",* Plenum, London (1997).
3. Thomas M, *"Cryogenic Engineering",* (1997).
4. HeselDen G G, *"Cryogenic Fundamentals"*, Academic Press, London (1971).
5. Flynn T M, *"Cryogenic Process Engineering",* Plenum (1989).

MEPE-406	Design for Production	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Sight and define problems to decide project.
CO 2	Solve project problem in conceptual range multi-options.
CO 3	Perform student estimate and analyses of solutions under corner realization capability, financial, utilitarian, information and other, make a decision and substantiate choice.

Detailed Syllabus

Product Design: Definition of product design, design by evolution, innovation and imitation, product life cycle, consumption cycle, types of products. Design process steps, morphology of design, relationship of innovation to design, management of research and development in the organization, role of technology transfer in innovation, problem solving and decision making techniques used in design, models used in design- physical and analytical, prototypes. Standardization, simplification and specialization in design, factors affecting product specifications and range, design for manufacturability, consideration of safety and reliability in design, economic analysis, time value of money, cost comparison, break-even analysis and cost benefit analysis. Role of value engineering, ergonomics and computers in design.

Ergonomics: Introduction, history of development, man-machine system and its components. Introduction to structure of the body- features of the human body, stress and strain, metabolism, measure of physiological functions- workload and energy consumption, biomechanics, types of movements of body members, strength and endurance, speed of movements. Applied anthropometry-types, use, principles in application, design of work surfaces and seat design.Visual displays for static information, visual displays of dynamic information, auditory, tactual and olfactory displays and controls.Effect of vibration, noise, temperature and illumination on performance.

Books Recommended

1. Karl T Ulrich and Steven D Eppinger, *"Product design and Development"*, McGraw-Hill Inc (2000).
2. George E Dieter, *"Engineering Design"*, McGraw-Hill Inc (2000).
3. R S Bridger, *"Introduction to Ergonomics",* McGraw-Hill Inc (1995).
4. Mark S Sandeer and Ernert J Mc Cormick, *"Human Factors in Engineering andDesign",* McGraw-Hill Inc (1993).
5. Kelvin Otto and Kristen Wood, *"Product Design",* Pearson Education, Delhi (2001).

MEPE-407	Energy Management	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	To impart knowledge in the domain of energy conservation
CO 2	To bring out Energy Conservation Potential and Business opportunities acrossdifferent user segments under innovative business models
CO 3	To inculcate knowledge and skillsabout assessing the energy efficiencyof an entity/ establishment

Detailed Syllabus

Introduction: Introduction to Energy codes and policies: Energy Conservation act, Electricity Act, Solar policy, Hydro policy, Biomass policy

Energy Analysis: Energy analysis: concept of embodied energy, energy analysis methodologies: process chain analysis, input-output method, inventory method; cumulative energy demand, energy yield ratio, energy payback

Environmental analysis: Environmental analysis: concept of carbon footprint of materials and systems, Numerical/mathematical modelling of environmental systems, environmental indicators of renewable energy systems, cumulative emission for renewable energy systems

Industrial energy management: Energy conservation in industrial systems: boilers, furnaces, pumps, fans and blowers, steam system, motors and transformers, power factor.
Energy audit: Process of energy audit, preliminary audit, detailed audit, reporting of energy audit

Reference Books:

1. Energy Management Handbook, Wayne C. Turner, Steve Doty, Taylor and Francis
2. Energy Management and Conservation, K. V. Sharma and P. Venkataseshaiah, Paperback Edition
3. Energy Management, W R Murphy, Paperback Edition
4. Energy Conservation Building Code (ECBC, 2016), Bureau of Energy Efficiency, India

MEPE-408	Experimental Stress Analysis	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Mechanics of Deformable Bodies (MEX-206), Design of Machine Elements (MEX-301)
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	The course is designed to provide practical knowledge and applications in experimental stress analysis. Students utilize current techniques to measure and analyze stress magnitudes and distributions.

Detailed Syllabus

Basic Elasticity: Laws of stress transformation, principal stresses and principal planes. Cauchy's stress quadric strain analysis, strain equations of transformation, stress-strain relationship.

Photo elasticity Method:
Two dimensional photo elasticity: Behaviour of light, Stress optics law, plane and circular polariscope, dark and light field arrangement, fringe multiplication, compensation techniques, commonly employed photo elastic materials.

Three dimensional photo elasticity: Newman's strain optic relationship, stress freezing in model materials for three dimensional photo elasticity, shear difference method for stress separation.

Coating:
Birefringence coatings: sensitivity, reinforcing effects, thickness of birefringence coatings.

Brittle coatings: Introduction, coating stresses and failure theories, different types of crack patterns, crack detection, composition of brittle coatings, coating cure, influence of atmospheric conditions, effects of biaxial stress field.

Electric resistance strain gauge: Gauge construction and installation, temperature compensation, gauge sensitivities, gauge factor, corrections for transverse strain effects, factors effecting gauge relation, rossettes, Rossettes analysis, potentiometer and whetstone's bridge circuits for strain measurement.

Books Recommended

1. Dally J E and Rilley W P, *"Experimental Stress Analysis",* 3rd Edition, McGraw Hill, New Delhi (1991).
2. Dove R C and Adams P H, *"Experimental Stress Analysis and Motion Measurement",* McGraw Hill, New York (1978).
3. Holister C S, *"Experimental Stress Analysis",* 5th Edition, Cambridge University Press (1987).
4. Dally J E and Rilley W P, *"Introduction to Photomechanics",* Prentice Hall Inc, NJ (1981).
5. Mubeen A, *"Experimental Stress Analysis",* 1st Edition Dhanpat Rai and Sons, New Delhi (1997).

MEPE-409	Fundamentals of Combustion	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understanding of basic dimensional units applied in the analysis of combustion systems.
CO 2	Understanding of the basics of equilibrium processes that impact on combustion.
CO 3	Understanding of the basics of combustion kinetics and mechanisms.
CO 4	Understanding of how fuel/waste characteristics affect important system behaviour and operational parameters
CO 5	Application of combustion engineering analysis principles to waste, boilers, burners, etc.
CO 6	Application of kinetic principles in the analysis of combustion systems.

Detailed Syllabus

Introduction.Chemical thermodynamics and chemical kinetics.Conservation equations for multi-component systems. Premixed systems - detonation and deflagration, laminar flames, effects of different variables on burning velocity, methods for measuring burning velocity,

flammability limits, ignition and quenching turbulent pre-mixed flames. Non-premixed systems: laminar diffusion flame jet, droplet burning. Combustion of solids: drying, devolatilization and char combustion. Practical aspects of coal combustion. Review of combustion fundamentals. Gas-fired furnace combustion.Oil-fired furnace combustion. Gas turbine sprays combustion. Combustion of solids.Industrial applications involving combustion.Burner design, testing and control.Emissions.Combustion safety.

Books Recommended:

1. Stephen R. Turns, *An Introduction to Combustion: Concepts and Applications*, 2nd Edition, Mc-Graw Hill, (2005).
2. Kenneth Kuan-yun Kuo, *Principals of Combustion*, John Wiley and Sons, NY (2005).
3. Charles E Baukal Jr., *Industrial Burners Hand Book*, CRC Press, Boca Raton, New York (2004).
4. Charles E Baukal Jr., *Heat Transfer in Industrial Combustion*, CRC Press, Boca Raton, New York Ed. (2005)
5. N H Afgan and J M Beer, *Heat Transfer in Flames*, Scripta Book Co., Washington D C (1974)

MEPE-410	Introduction to Finite Element Methods	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO 1	Review the mathematical knowledge studied in previous semester.
CO 2	To understand the advantage of discreatization of the object.
CO 3	To develop familiarities with FEM software.
CO 4	To develop program for solving the problems.

Detailed Syllabus

Fundamentals of the Finite Element Method, discritization of the domain, one-two and three dimensional elements and interpolation functions, local and global coordinates, properties of interpolation functions, compatibility and completeness requirements, Assembly and boundary conditions; Formulation for FEM solutions.Application to solid mechanics, vibrations, plates and shell problems.

Books Recommended

1. Desai and Abel, *"Introduction to Finite Element Method",* East West, CBS Delhi (1987).
2. Zienkiewicz O C, *"Finite Element Method",* McGraw Hill (1989).
3. Krishnamurthy C J, *"Finite Element Method – Analysis Theory and Programming",* Tata McGraw Hill (1994).
4. Bathe k J, *"Finite Element Procedures",* Prentice Hall of India Private Limited, New Delhi, (1996).
5. Belegundu Ashok D and Chandrupatla T, *"Introduction to Finite Element Method",* PHI Private Limited, New Delhi (2003).

MEPE-411	Materials and Environment	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Understand the importance of materials and interrelationship between Materials, Energy, Emissions and Environment
CO 2	Carryout Life Cycle Assessment (LCA), Eco Audits using various methods
CO 3	Understand the importance of materials selection in the Mechanical Design process and use Material property charts, Material Indices for selecting materials for various types of mechanical systems
CO 4	Introduce the concept of Ecological Selection of Materials.

Detailed Syllabus

Introduction Material Dependence: Introduction and synopsis, Materials: a brief history, Learned dependency: the reliance on nonrenewable materials, Materials and the environment.

Resource Consumption & its drivers: Resource consumption, Exponential growth and doubling times, Reserves, the resource base, and resource life, Summary and conclusion.

The Materials Life Cycle: The material life cycle, Life-cycle assessment: details and difficulties, Streamlined LCA, The strategy for eco-selection of materials.

End of First Life- A Problem or a resource: What determines product life, End-of-first-life Options, The problem of packaging, Recycling: resurrecting materials.

Eco Data-Values, Sources, precision: Data precision- recalibrating expectations, The eco-attributes of materials, Energy and CO2 footprints of energy,transport, and use, Exploring the data: property charts.

Eco Audits & Eco Audit Tools: Introduction and synopsis, Eco-audits, Computer-aided eco-auditing, Case Studies.
Selection Strategies: Introduction, The selection strategy: choosing a car, Principles of materials selection, Selection criteria and property charts, Resolving conflicting objectives: tradeoff methods.

Eco-Informed Material Selection: Which bottle is best? Selection per unit of function, Crash barriers: matching choice to purpose, Deriving and using indices: materials for light, strong shells, Heating and cooling, Transport.

Sustainability- Living on Renewables: The ecological metaphor, Sustainable energy, sustainable materials, Future options.

Books Recommended:

1. Ashby M, “Materials& the Environment- Eco-Informed Material Choice” , Butterworth-Heinemann (2019)
2. Ashby M, “Materials and Sustainable Development”, Butterworth-Heinemann (2016)

3. Ashby M, "Materials Selection in Mechanical Design", Third Edition, Elsevier, Indian Edition, (2005)
4. Ashby M and Johnson K, "Materials & Design, 2nd Edition- The Art & Science of Material Selection in Product Design", Butterworth-Heinemann (2009)

MEPE-412	Materials and Sustainable Development	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Understand the importance of materials and interrelationship between Materials, Energy, Emissions and Environment
CO 2	Carryout Life Cycle Assessment (LCA), Eco Audits using various methods
CO 3	Understand the meaning and importance of sustainable development, assessment methods/techniques for sustainable development with various case studies
CO 4	Evaluate Materials supply chain risk and understand concept of CSR.

Detailed Syllabus

Introduction Material Dependence: Introduction and synopsis, Materials: a brief history, Learned dependency: the reliance on nonrenewable materials, Materials and the environment.

Resource Consumption & its drivers: Resource consumption, Exponential growth and doubling times, Reserves, the resource base, and resource life, Summary and conclusion.

The Materials Life Cycle: The material life cycle, Life-cycle assessment: details and difficulties, Streamlined LCA, The strategy for eco-selection of materials.

Eco Data-Values, Sources, precision: Data precision- recalibrating expectations, The eco-attributes of materials, Energy and CO2 footprints of energy,transport, and use, Exploring the data: property charts.

Eco Audits & Eco Audit Tools: Introduction and synopsis, Eco-audits, Computer-aided eco-auditing, Case Studies.

Sustainable Development: Introduction, Definitions, Triple Bottom Line Approach, Articulations of sustainable development, Assessing sustainable development, layered approach to assess sustainable development, Tools for assessment, Defining objective, stake holder analysis, fact finding, synthesis.

Materials Supply chain risk: Emerging constraints on materials sourcing and usage, price volatility risk, monopoly of supply and geo political risk, conflict risk, legislation & regulation risk, other risks.

Corporate Sustainability & materials: Introduction, Corporate social responsibility & sustainability reporting, Case Studies on Corporate SR's.

Case Studies on Sustainable development: Bioploymers to replace oil based plastics, Wind Farms, Electric Cars, Solar PV for Low Carbon power, Bamboo as sustainable building material.

Books Recommended:

1. Ashby M, "Materials and Sustainable Development", Butterworth-Heinemann (2016)
2. Ashby M, "Materials & the Environment- Eco-Informed Material Choice" , Butterworth Heinemann (2019)
3. Ashby M, "Materials Selection in Mechanical Design", Third Edition, Elsevier, Indian Edition, (2005)
4. Ashby M and Johnson K, "Materials & Design, 2nd Edition- The Art & Science of Material Selection in Product Design", Butterworth-Heinemann (2009)

MEPE-413	Materials in Mechanical Design	Department Elective	L	T	P	Credit
			3	0	0	3

Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understand the importance of materials selection in the Mechanical Design process and use Material property charts, Material Indices for selecting materials for various types of mechanical systems
CO 2	Understand the importance of shape and various shape efficiency factors in the design process
CO 3	Solve problems involving multiple objectives and constraints
CO 4	Designing Hybrid materials and to undertake analysis of Eco properties of materials.

Detailed Syllabus

Introduction: Materials in design, evolution of engineering materials, Design tools and materials data, Function, material, shape and process. Review of properties of Engineering materials and nomenclature of materials.

Material Selection: Introduction, displaying material properties, material property charts Basics concerning material selection, selection strategy, property limits and material indices, selection procedure and structural index. Material selection –case studies

Selection of Materials and Shape: Shape factor, efficiency of standard sections, materials for shape factors, material indices, microscopic or micro-structural shape factor and co-selecting material and shape. Shape case studies.

Multiple constraints and compound objectives selection by successive application of property limits and indices, methods of weight factors, methods using fuzz logic, systematic methods for multiple constraints, compared objectives, exchange constrains and value functions. Case studies.

Materials processing design: Processes and their influence attributes, systematic process selection, screening process selection diagrams, Ranking – process cost, supporting information. Case studies related to processing design.

Designing Hybrid Materials: Introduction, Filing holes in material-property space, Composites, Sandwich Structures, lattices, Segmented structures, Case Studies.

Materials and Environment: Introduction, The material life cycle, Material and energy-consuming systems, The eco-attributes of materials, Eco-selection, case studies.

Books Recommended:

1. Ashby MF, *"Materials Selection in Mechanical Design",* Third Edition, Elsevier-Butterworth Heinemann, (2005).
2. Budinski KG, "*Engineering Materials: Properties & Selection*", 6th Edition, Prentice Hall, (1999).
3. Dieter GE, "*Engineering Design: A materials & Processing Approach*", 3rd Edition, McGraw Hill, (2000).
4. Ashby MF, Johnson K, "*Materials & Design- The Art and Science of Materials Selection in Product Design*", Butterworth Heinemann, (2002).

MEPE-414	Metal Cutting and Machine Tools	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Mechanical Measurement & Metrology (MEX-307).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Apply cutting mechanics to metal machining based on cutting force and power consumption.
CO 2	Operate lathe, milling machines, drill press, grinding machines, etc.
CO 3	Students will be able to analyze cutting forces in turning, drilling and milling.
CO 4	Select appropriate machining processes and conditions for different metals.
CO 5	Students will be able to adjust varies parameters and reduce temperature developed during machining.
CO 6	Learn machine tool structures and machining economics. Students will be able to reduce the cost of machinery.
CO 7	Students will be able to prevent failures of cutting tool.
CO 8	Write simple CNC programs and conduct CNC machining.

Detailed Syllabus

Machining of Metals: Mechanics of metal cutting, Cutting Tool Nomenclature, Orthogonal and Oblique Cutting, Tool Angle Specification Systems, Effect of Cutting Parameters on Tool Geometry, Temperature at the Shear Plane in orthogonal Cutting, Experimental Determination of Tool Temperature.

Tool Wear and Cutting Fluids: Cutting Fluids, Types of Cutting Fluids, Selection of Cutting Fluids, Methods of Applying Cutting Fluids, Kinds of Tool Damage, Tool Wear Equation, Tool Life Equations, Tool Life Tests.

General Purpose Machine Tools and Operations: Lathe and turning operations, Lathe and its accessories, Lathe specifications, lathe cutting tools, Classification of milling machines, specifications of milling machine, milling machine operations, indexing methods: simple and compound indexing. Shaper and Planes, Grinding Machines, Drilling Machines.

Introduction to new Machining Processes.

Mechanisms for rectilinear motion: Methods for producing rectilinear motion in machine tools, Rack and pinion drives, rotary and materials uses for pinions and racks, worm and rack drives, materials used, lead screw and nut drives, materials used for bad screws and nuts.

Structural Features of Machine Tools: Beds, Bases columns, material for beds, bases and columns typical constructions of beds, bases and columns, machine tool columns, Housings, Tables cross rails and carriages.

Frames and Guides: Sideways, Antifriction ways, circular ways.

Speed and Feed Gear Boxes: Speed gearboxes in machine tools, types of speed gearboxes, feed gearboxes, types of feed gearboxes.

Introduction to Numerical Control of Machine Tools.

Installation and maintenance of machine tools: Machine Tool installation and maintenance safety in machine tools, reconditioning of machine tools, trouble shooting.

Books Recommended

1. Devris W R, *"Analysis of Material Removal Processes"*, Springer – Verlag (1992).
2. Panday P C and Shan H S, *"Modern Machining Processes"*, Tata McGraw Hill Publishing Company Limited, New Delhi (1980).
3. Schey A John, *"Introduction to Manufacturing Processes"*, McGraw Hill Book Company, New York (1987).
4. HMT Bangalore, *"Production Technology"*, Tata McGraw Hill, New Delhi (1980).
5. Acherkan N, *"Machine Tool Design"*, Volume 1 to 4, MIR Publishers, Moscow (1969).

MEPE-415	Metal Forming	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	The students should learn and understand the necessity of forming process compared with other manufacturing techniques.
CO 2	The learning of various forming methods gives an idea for the selection of process for different materials.
CO 3	Students will be able to analyse the stresses and yield criteria used for the deformation analysis of the different metal forming process.
CO 4	Students should be able to select the process, load required and possible reason the formation defects for the forged, rolled, extruded components.
CO 5	The students should have the knowledge to identify production of wire, rod , tubes using different process and problems occurred in the process.

Detailed Syllabus

Stress and strain analysis, yield conditions, stress strain relation in elastic and plastic deformations, hardening, formulations of elastic and plastic problems, methods of solution, slab method, slip line and Extremum Principles, applications of theory of plasticity to metal working operations like wire drawing, extrusion, rolling, forging, deep drawing, spinning etc. Friction in metal working, recent developments in technology and theory.

Books Recommended:

1. Harris J N, *"Mechanical Working of Metals: Theory and Practice",* 1st Edition, Pergamon, New York (1983).
2. Mielnik E M, *"Metal Working Science and Engineering"*, McGraw Hill (1991).
3. Wagoner H Robernt, Chenot Iean-Loup, *"Fundamentals of Metal Forming"*, Wiley Text Books (1996).
4. Proceedings of the Conference, *"Mechanical Working and Steel Processing 20th"*, Iron and Steel Society (1983).
5. Kumar S, *"Principles of Metal Working",* Oxford and IBH Publishing Company, New Delhi (1985).

MEPE-416	Microfluidics and Nanofluidics	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

Detailed Syllabus

Overview on microfluidics/nanofluidics, basic fluid mechanics and heat transfer, governing equations and slip models, shear-driven flows, pressure-driven flows, thermal effects in microscales, electrokinetic flows and applications, electrokinetic flows acoustofluidics and optofluidics with applications, surface tension-driven flows, introduction to microfabrication, nanofluids and applications.

Books Recommended:

1. Nguyen, Nam-Trung, Steven T. Wereley, and Seyed Ali Mousavi Shaegh. Fundamentals and applications of microfluidics. Artech house, 2019.
2. Karniadakis, George, Ali Beskok, and Narayan Aluru. Microflows and nanoflows: fundamentals and simulation. Vol. 29. Springer Science & Business Media, 2006.
3. Abgrall, Patrick, and Nam-Trung Nguyen. Nanofluidics. Artech House, 2009.
4. Bruus, Henrik. Theoretical microfluidics. Vol. 18. Oxford: Oxford university press, 2008

MEPE-417	Modal Analysis of Mechanical Systems	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Learn the basics of mechanical vibrations and predict the modal-model i.e., natural frequencies, mode shapes and damping coefficient of simple systems. Understand the concept of state- space model. Also, learn the concept of frequency response function (FRF).
CO2	Understand the vibration measuring instruments and predict the FRF at different excitations.

CO3	Design the FRF for Single and multi-degree of freedom systems
CO4	Understand the modal-model, response model, spatial models, mobility skeletons and system models. Learn the application of experimental modal analysis on mechanical systems.

Detailed Syllabus

Overview: Applications of Modal Testing, Philosophy of Modal Testing, Summary of Theory,
Summary of Measurement Methods, Summary of Modal Analysis Processes, Review of test procedures, and levels, Terminology and Notation.

Theoretical Basis: Single-Degree-of Freedom (SDOF) system theory, Presentation and properties of FRF Data for SDOF system, Undamped Multi-Degree-of Freedom (MDOF) system, MDOF systems with proportional damping, MDOF systems with structural (hysteretic) damping – General case, MDOF systems with viscous damping – general case, Modal Analysis of Rotating Structures, Complex Modes, Characteristics and presentation of MDOF FRF Data. Non-sinusoidal Vibration and FRF properties.

Response Function Measurement Techniques: Basic measurement system, Structure Preparation, Excitation of the Structure, Transducers and amplifiers, Analyzers, Digital signal processing, use of different excitation signals, calibration, mass cancellation, rotational FRF measurement, measurements on non-linear structures, multi-point excitation methods, measuring
FRFs and ODSs using the scanning LDV.

Modal Parameter Extraction Methods: Preliminary checks of FRF data, SDOF modal analysis, methods, MDOF modal analysis in the frequency domain (SISO), global modal analysis in the time domain, modal analysis of non-linear structures, concluding comments.

Derivation of Mathematical Models: Modal models, refinement of modal models, display of modal model, response model, spatial models, mobility skeletons and system models.

Applications: Comparison of and correlation of experiment and prediction, adjustment or updating of models, coupled and modified structure analysis, response prediction and force determination, test planning.

Books Recommended:

1. Ewins D J, “Modal Testing: Theory and Practice” Research Studies Press Ltd 1985.
2. He and fu “Modal Analysis” Elsevier Science & Technology 2001.
3. J M M Silva & N M M Maia “Modal Analysis and Testing” Kluwer Academic Publishers Group 1999.
4. G Conciauro, M Guglielmi, R Sorrentino “Advanced Modal Analysis” John Wiley & Sons 2000.

MEPE-418	Next Generation Automotive Mobility Engineering	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

CO1	Learn the basics of future mobility solutions
CO2	Understanding of Internal Combustion Engine, Electric Motor and Fuel cell Driven Vehicles for variable applications.

Detailed Syllabus

Awareness towards Future Mobility Solutions, Motor Vehicles Act, Emission Norms, Safety and Sustainability Issues.Passenger, Commercial and Recreational vehicles.
Role of Onboard Diagnostics and Control.
Understanding of Internal Combustion Engine, Electric Motor and Fuel cell Driven Vehicles.
Knowledge of Structure, Suspension, Transmission and Vehicle Dynamics.
Battery Power Packs, Lead Acid, Li Ion and Super capacitors and their combination.
Charging Stations, Normal, Fast and Ultra-Fast.
Understanding and Application of Computer Aided Engineering Hardware and Software.
Use of vehicles as Power Plants.Application of Renewable Energy in Next Generation Automobiles.
Autonomous and Smart Vehicles.
Job Opportunities and Entrepreneurial aspects leading to self-employment.

Books Recommended

1. Crouse, William H., and William Harry Crouse. *Automotive Mechanics*. Tata McGraw-Hill Education, 10th Ed., 2007
2. Bosch, Robert. *Automotive Electrics, Automotive Electronics*. Wiley, 2007.
3. Agarwal A., Gupta J., Sharma N., Singh A. (eds) *Advanced Engine Diagnostics. Energy, Environment, and Sustainability*. Springer, Singapore.
4. Ehsani, Mehrdad, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi. *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*. CRC press, 2018.

MEPE-419	Noise Engineering	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Learn the basics of noise and acoustics. Understand and correlate the vibration with noise. Understand the noise measurement system
CO2	Predict the noise generated by various vibration sources
CO3	Learn the active and passive noise control system

Detailed Syllabus

Course contents:
Introduction to Engineering acoustics, review of normal mode analysis, random vibration and spectral analysis, wave approach to sound, noise measurement and instrumentation standards, sound pressure, power and intensity, noise radiation from vibrating bodies, noise source

identification, noise in machines and machine elements, fan and flow noise, combustion noise, noise in piping systems, industrial noise, jet noise, response of structures to noise, active and passive noise control, human factors in noise engineering.

Books Recommended:

1. Fahy F, and Gardonio P, "*Sound and structural vibration, radiation, transmission and response*", Academic Press (1985)
2. Norton M.P., "*Fundamentals of Noise and Vibration Analysis for Engineers*", Cambridge University Press (2003)
3. Ambekar A. G., "Mechanical *Vibrations and Noise Engineering*", PHI Learning (2006)
4. David A. B., Colin H., Carl H., "Engineering *Noise Control*", CRC press (1992)
5. Michael M. "Engineering *Acoustics: An introduction to noise control*", Springer

MEPE-420	Non-Conventional Energy	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To make the students aware about the present energy scenario and importance of non conventional energy resources.
CO 2	To know about the various prevalent, non conventional energy resources and their respective worldwide with specific to India.
CO 3	To acquire the knowledge related to various energy conversion technologies, Direct and Indirect.
CO 4	To develop an ability for design and analysis of various energy conversion systems and devices.
CO 5	Introduce students to societal catalysts and challenges regarding renewable energy implementation.
CO 6	To enhance a student's ability to communicate in written form.

Detailed Syllabus

Wind Energy: Basic principle of wind energy conversion, wind data and energy estimation, site selection considerations, basic components of a WECS, classification of WECS system, application of wind energy.

Biomass Energy: Biomass conversion technologies, photosynthetic, biogas generation, factors affecting bio-digestion, classification of biogas plants with their advantages and disadvantages, types of biogas plants, constructional details of digesters, site selection for biogas plants, methods of obtaining energy from biomass.

Geothermal Energy: Nature of geothermal fields, types of geothermal sources. Advantages and disadvantages of geothermal energy over other energy forms, application of geothermal energy, geothermal energy prospects in India.

Energy from Ocean: Ocean thermal electric conversion, methods of ocean thermal elective power generation, energy from tides, basic principal of tidal power, components of tidal

power plant, methods of utilization of tidal energy ocean waves and introduction and wave energy conversion devices.

Fuel Cell: Design and principle of operation of fuel cell, classification of fuel cells.

Magneto Hydrodynamic Power Generation: Principle of MHD power generation, types of MHD systems.

Thermo Electric Power: Basic principle of thermoelectric power generation, thermoelectric materials, selection of materials.

Thermionic Generation: Thermionic emission and work function, basic thermionic generator.

Hydrogen Energy: Hydrogen production, hydrogen storage and transportation, hydrogen as a alternative fuel for motor vehicles.

Books Recommended

1. Rai G D, *"Non-Conventional Energy Sources",* 4th Edition, Khanna Publishers, Delhi (1999).
2. Rao S and Paruleka B B, *"Energy Technology",* 1st Edition Khanna Publishers, Delhi (1999).
3. Abbasi S A and Abbasi Narsema, *"Renewable Energy Sources and their Environmental Impact",* Prentice Hall of India Private Limited, New Delhi (2001).
4. Kothari,D.P,Singal,K.C. & Ranjan, Rakesh, " Renewable Energy sources and Emerging Technologies", Ist Edition Prentice Hall of India(2008).

MEPE-421	Numerical Control for Machine Tool	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Student will enable to understand the functioning of NC, CNC and DNC Machine tools.
CO 2	Enable to understand and use Adaptive Control System to increase productivity, increase tool life and reduce rejections.
CO 3	Generate manual/computer assisted programs for a given part to be machined on NC/CNC system.

Detailed Syllabus

Introduction: Basic concepts of manufacturing system and CAD/CAM. NC/CNC machine tools, NC machine tools-basic components, coordinate systems, features of NC machine tools. Computerized numerical control (CNC), tooling for NC machines-tool, presetting equipment, flexible tooling, tool length compensation, tool path graphics, NC motion control system, manual part programming, fixed/floating zero. block format and codes, computer assisted part programming. DNC and adaptive control, direct numerical control, adaptive control in machining system, combined DNC/CNC system.

Books Recommended

1. Zeid Ibraham, *"CAD/CAM Theory and Practice",* Tata McGraw Hill Publishing Company (1999).
2. Chris McMohan, *"CAD/CAM:Principles: Practice and Manufacturing Management"*, Pearson Education India (1998).
3. Groover M, *"Computer Aided Design and Manufacturing"*, Pearson Education India (2003).
4. Rao P N, *"CAD/CAM"*, Tata McGraw Hill Publishing Company (1999).
5. Bedworth D and Henderson M R, *"Computer Integrated Design and Manufacturing"*, Tata McGraw Hill Publishing Company (1998).

MEPE-422	Numerical Heat Transfer	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

CO 1	To enable the students to understand the physics of different modes of heat transfer and importance of the subject of heat transfer in day to day life and in engineering applications.
CO 2	To enable the students to take up different problems related to heat transfer and write the corresponding mathematical models for them.
CO 3	To develop a competence in the students to solve heat transfer problems analytically by incorporating appropriate approximations in the complex models.

Detailed Syllabus

Introduction.1-, 2- and 3-D heat conduction for steady state and transient conditions.Initial and boundary conditions, implementation and solution methods. Diffusion and advection heat transports. Discretization methods.Grid generation.Convection in incompressible flows.Staggered grid.SIMPLE and SIMPLER pressure-velocity coupling methods.External and internal flow simulations.

Books Recommended

1. S. V. Patankar, Numerical heat transfer and fluid flow, CRC press, (1980).
2. Tucker, P. G., Advanced computational fluid and aerodynamics, Cambridge University Press. (2016).
3. D. Anderson, et al. Computational fluid mechanics and heat transfer, CRC Press, (2016).

A. Sharma, Introduction to Computational Fluid Dynamics: Development,

4. Application and Analysis, John Wiley & Sons. (2016).
5. P.S. Ghoshdastidar Computer Simulation Of Flow And Heat Transfer, Tata Mcgraw Hill, (1998).
6. H. K. Versteeg, W. Malalasekera, An Introduction To Computational Fluid
7. Dynamics: The Finite Volume Method, (2nd Edition), Prentice Hall.
8. S.M. Ghiaasiaan, Convective heat and mass transfer, ghiaasiaan SM, Cambridge press, (2014).

MEPE-423	Robotics: Mechanics and Control	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understand the importance of robotics and its impact on human safety, quality of life, economy, environment.; basics of open ended type robotic manipulators.
CO 2	Understand the kinematics and dynamics of open ended robotic mechanism; Fixing frames using the Denavit-Hartenberg convention, Jacobian, singularity, Newton-Euler formulations for dynamics of rigid body systems.
CO 3	Ability to formulate, derive, analyse and synthesize kinematics and dynamics of open ended robotic mechanisms.
CO 4	Understand and apply detailed concepts relating to various actuators, sensors, and their integration with drives and signal conditioning for robotics.
CO 5	Understanding concepts of feedback control of robotic manipulators based on modern control theory;PID Control; and applying them to Joint control and trajectory control.

Detailed Syllabus

Introduction to Robotics:
Kinematics and Dynamics of Robotic linkages (open ended type manipulators):
Frames, Transformations: Translation and rotation, Denavit-Hartenberg parameters, Forward and Inverse Kinematics, Jacobian, Dynamics: Equations of motion, Newton-Euler formulation.

Sensors and actuators:
Strain gauge, resistive potentiometers, Tactile and force sensors, tachometers, LVDT, Piezo electric accelerometer, Hall effect sensors, Optical Encoders, Pneumatic and Hydraulic actuators, servo valves, DC motor, stepper motor, drives.

Control of Manipulators:
Feedback control of II order Linear systems, Joint control, Trajectory control, Controllers, PID control.

Books Recommended

1. John J. Craig, *Introduction to Robotics: Mechanics and Control*, Addison-Wesley, 2005.
2. Tsuneo Yoshikawa, *Foundations of Robotics*, MIT Press, 1990.
3. Saeed B. Niku, *Introduction to Robotics: Analysis, Systems, Applications*, Pearson Education Inc., 2001
4. Spong M. W., and Vidyasagar M., *Robot Dynamics and Control*, John Wiley & Sons, 1989.
5. Murray R. M., et al, *A Mathematical Introduction to Robotic Manipulation*, CRC Press, 1994.
6. Waldron K. J., and Kinzel G. L., *Kinematics, Dynamics and Design of Machinery*, John Wiley & Sons, 2004.

7. Eronini Umez-Eronini, *System Dynamics & Control*, Brooks/ Cole Publishing Company, 1999.
8. Amalendu Mukherjee, Ranjit Karmakar and Arun Kumar Samantaray, *Bond Graph in Modeling, Simulation and Fault Identification*, I. K. International Publishing House Pvt. Ltd, 2006.

MEPE-424	Solar Thermal Process	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Study of the Solar radiation on the earth surface and its characteristics, instruments used to measure solar radiation, solar radiation data, solar radiation geometry.
CO 2	Analysis of Flat plate collectors, principles of energy conversion into heat, energy balance equation, collector efficiency.
CO 3	Study of Solar energy storage like scribble heat storage, latent heat storage, thermo chemical heat storage.
CO 4	Understanding and designing Solar water heating system, pressurized and non pressurized, space heating and cooling.

Detailed Syllabus

Solar Radiation: Solar radiation outside the earth's atmosphere, solar radiation at the earth's surface, instruments for measuring solar radiation and sunshine, solar radiation data, solar radiation geometry, solar radiation on tilted surfaces.

Solar Energy Collection: Flat – Plate collectors: Transmissivity of cover system, physical principles of conversion of solar radiation into heat, energy balance equation and collector efficiency, concentrating collectors: Focusing type, selective absorber coating.

Thermal Energy Storage: Scribble heat storage, latest heat storage, thermo-chemical heat storage.

Solar Water Heating Systems: Natural circulation water heater; (pressurized and non-pressurized) Forced circulation solar water heater, space heating and cooling.

Solar Crop Drying: Working principle: Open sun drying, direct solar drying, and indirect solar drying.

Solar Distillation and Solar Pond and other Applications: Worming Principle, principle and description of solar pond and operational problem, collection – cum storage water heater, Green house, solar cooker, heating of biogas plant by solar energy.

Books Recommended

1. Sukhatme S P, "*Solar Energy: Principles of Thermal Collection and Storage*", 2nd edition, Tata McGraw Hill, Delhi (1997).

2. Tiwari G N, *"Solar Energy: Fundamentals, Design, Modeling and Applications"*, 1st Edition, Narosa Publishing House, New Delhi (2003).
3. Rai G D, *"Non-Conventional Sources of Energy"*, 4th Edition, Khanna Publisher, Delhi (1999).
4. Agarwal M P, *"Solar Energy"* S Chand & Sons, New Delhi (1989).
5. Garg H P and Parkash J, *"Solar Energy: Fundamentals and Applications"*, Tata McGraw Hill, Delhi (2003).

MEPE-425	System Design	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Design of Machine Elements (MEX-301).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Apply Statics, Dynamics and Strength of materials to machine component design.
CO 2	Ability to perform selection of size, design and analysis of mechanical components/ systems.
CO 3	Ability to select the material, thermo-mechanical condition and configuration of a variety of machine elements and drives under a variety of environmental and service conditions.
CO 4	To enable students to learn how to identify and quantify the specifications for selection and application of components those are used in the design of mechanical systems.

Detailed Syllabus

System Design involves preparing of complete design of system, production drawings for selected projects in power drive, engines, machine tools, mechanical handling equipment etc.

Books Recommended

1. Norton L R, *"Machine Design an Integrated Approach"*, Ist Indian Reprint, Pearson Education Asia (2001).
2. Sharma P C and Aggrawal D K, *"A text book on Machine Design"*, 9th Edition, S K Kataria and sons (2000).
3. Shigley J E and Mischke C R, *"Mechanical Engineering Design"* Tata Mcgraw Hill, New Delhi, (2003).
4. Acherkan N, *"Machine Tool Design",* Volume 1 to 4, MIR Publishers, Moscow (1969).
5. Burr H and John B Cheatham, *"Mechanical Analysis and Design"*, PHI Private Limited, New Delhi (2001).

MEPE-426	Theory of Elasticity	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Advance Solid Mechanics
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Be able to derive the governing equations for 2D and 3D elastic problems.
CO2	Be able to analysis of stress and deformation.
CO3	To apply the basic field equations of linear elastic solids in various boundary value problems.
CO4	To solve these problems with various solution methodologies.

Detailed Syllabus

Analysis of Stress: Concept of Stress, Stress Components, Equilibrium Equations, Stress on a General Plane (Direction Cosines, Axis Transformation, Stress on Oblique Plane through a point, Stress Transformation), Principal Stresses, Stress Invariants, Deviatoric Stresses, Octahedral Stresses, Plane Stress, Stress Boundary Condition Problem.

Analysis of Strain: Deformations (Lagrangian Description, Eulerian Description), Concept of Strain, Strain Components (Geometrical Interpretation), Compatibility Equations, Strain transformation, Principal Strains, Strain Invariants, Deviatoric Strains, Octahedral Strains, Plane Strain, Strain Rates.

Stress-Strain Relations: Introduction, One-Dimensional Stress-Strain Relations (Idealized Time-independent and Time dependent stress-strain laws), Linear Elasticity (Generalized Hooke s Law), Stress-Strain Relationships for Isotropic and Anisotropic Materials (Plane stress and Plane Strain).

Basic Equations of Elasticity for Solids: Introduction, Stresses in Terms of displacements, Equilibrium Equations in terms of displacements, Compatibility equations in Terms of Stresses, Special cases of Elasticity equations (Plane Stress, Plane strain, Polar Coordinates), Principle of Superposition, Uniqueness of Solution, Principle of virtual work, Potential and Complementary energy, Variational Principles, St. Venant s Principle, Methods of analysis for Elastic Solutions, Elastic solutions by Displacement and stress Functions, Airys Stress Function (Plane stress, Plane strain, Polar Co-ordinates).

Torsion: Introduction, Circular shaft, Torsion of non-circular cross-section, St. Venant's theory, Warping function, Prandtl s stress function, Shafts of other cross-sections, Torsion of bars with thin walled sections.

Books Recommended

1. Mathematical Theory of Elasticity by I. S. Sokolnikoff.
2. Advanced Mechanics of Materials by Boresi.
3. Theoretical Elasticity by A. E. Green and W. Zerna.
4. Theory of Elasticity, Timoshenko, S.P., and Goodier, J.N., McGraw-Hill

MEPE-427	Theory of Plasticity	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Advance Solid Mechanics and Theory of Elasticity
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Be able to define stress and strain in 3D system for plastic region with related laws and problems
CO2	Be able to describe mechanism of plastic deformation from fundamentals of material science
CO3	To calculate true stress and strain in plastic deformation
CO4	To understand the physical interpretation of material constants in mathematical formulation of constitutive relationship
CO5	To solve analytically the simple boundary value problems with elasto-plastic properties
CO6	Be able to illustrate slip line field theory and their geometry and property

Detailed Syllabus

Introduction to plasticity: Resolved shear stress & strain, Lattice slip systems, Hardening, Yield surface, Flow rule, Micro to Macro plasticity. Stresses and Strains: The Stress–Strain Behaviour, Analysis of Stress, Mohr's Representation of Stress, Velocity gradient and rate of deformation, Kinematics of large deformation, The Criterion of Yielding, Yielding of materials under complex stress state, Choice of yield function.

Non-Hardening & Elastic-Perfect Plasticity: Classical theories and its application to uniform & non uniform stress states, Hencky vs. Prandtl-Reuss, Elastic–Plastic Torsion and Bending of Beams, Thick walled cylinders.

Theory of the Slipline Field: Formulation of the Plane Strain Problem, Properties of Slipline Fields and Hodographs, Stress Discontinuities in Plane Strain, Construction of Slipline Fields and Hodographs, Analytical and Matrix Methods of Solution, Explicit Solutions for Direct Problems, Some Mixed Boundary-Value Problems, Superposition of Slipline Fields.

Limit Analysis: Collapse of Beams & Structures, Transverse loading of circular plates.

The Flow Curve: Uniaxial tests, Torsion tests, Compression tests, Bulge test, Equations to flow curve, Strain & work hardening hypothesis.

Plasticity with Hardening: Isotropic hardening, Non associated flow rules, Prandtl-Reuss flow theory, Kinematic hardening.

Plastic Instability: Inelastic buckling of struts, Buckling of plates, Tensile instability, Circular bulge instability, Plate stretching.

Books Recommended

1. Theory of Plasticity: J. Chakrabarty.
2. Basic Engineering Plasticity: DWA Rees.
3. The Mathematical theory of plasticity: R.Hill.
4. Continuum Theory of Plasticity: S. Huang.
5. Fundamentals of the Theory of Plasticity: L.M. Kachanov.
6. Plasticity for Engineers: Theory and Applications: C. R. Calladine.
7. Plasticity: Fundamentals and applications, P. M. Dixit and U. S. Dixit
8. Nonlinear Solid Mechanics, D. Bigoni

MEPE-428	Tool Design	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understand the fundamental principles of conventional machine tools and CNC machine tools for the desired machining purpose.
CO 2	Develop the ability to identify, formulate and solve engineering problems by applying knowledge of machine tool design.
CO 3	An ability to use techniques, skills and modern engineering tools necessary for engineering practice.

Detailed Syllabus

Tool Design Methods: Introduction, The Design Procedure, Drafting Practice, Drawing Layout.

Tool Making Practice: Introduction, tools of the toolmaker, hand finishing and polishing, screws and dowels, jig boring practice, punch and die manufacture, electrodischarge machining for cavity applications.

Tooling Materials and Heat Treatment: Introduction, properties of materials, ferrous tooling materials, nonmetallic tooling materials, factors affecting heat treatment, heat treatment and tool design.

Design of Cutting Tools: The basic requirements of a cutting tool, general considerations for metal cutting, design of single point cutting tools, milling cutters, drills and drilling, reamers taps, carbide tools.

Sheet Metal Dies: Blanking and piercing die construction, press work materials, strip layout, bending dies, forming dies, drawing operations, single and double action draw dies.

Principles of Tool Design for Forging, Extrusion and Dies Casting: Introduction, general principles.

Tool Design for Numerically Controlled Machine Tools: Need for numerical control, fixture design for numerically controlled machine tools, cutting tools for numerical control, tool-holding methods for numerical control, automatic tool changers and tool positioners, tools presetting.

Books Recommended

1. Donaldson Cyril, Lecain George H, Goold V C, *"Tool Design",* Tata McGraw Hill Publishing Company Limited, New Delhi (1993).
2. Battacharayya A and Ham L, *"Design of Cutting Tools",* SME, Dearborn, Mich (1969).
3. Paquin J R, *"Die Design Fundamentals",* The Industrial Press, New York (1962).
4. Wilson F W, *"Fundamentals of Tool Design"*, Prentice Hall, Englewood Cliffs, N J (1962).

5. Wilson F W, *"Numerical Control in Manufacturing"*, McGraw Hill, New York (1963).

MEPE-429	Unconventional Methods of Machining	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Student will learnthe technology and history for the development of newer/ non-traditional machining process.
CO 2	The students will demonstrate the comparison between non-traditional with the traditional machining processes with respect to the different parameters- Energy sources; Economics of the processes; Shape and size of material etc.
CO 3	The students analyse the concept, mechanism of material removal with respect to different processes.
CO 4	Different parameters associated with the process, their influence on the machining, will be analysed.
CO 5	Advantages, applications and limitations of the various non-traditional machining processes will be evaluated.

Detailed Syllabus

Introduction: Mechanical Processes, Material removal theories, Fundamental principles, Process parameter characteristics, Metal removal rate analysis, Principles and Mechanism of Water jet machining, Abrasive jet machining, Ultrasonic machining.

Chemical and Electro-Chemical Machining: Introduction, Principles, Process parameters, Applications, limitations, Kinematics, Dynamics and Hydro-dynamics, Analysis of Material removal, Introduction to lithography.

Electric Discharge Machining: Basic Principles and Scheme Circuitrary controls, Metal removal rate, Machining Accuracy Optimization, Selection of Tool Material, Dielectric, Analysis of the Process.

Laser Beam Machining & Electron Beam Machining: Introduction, Production of Laser, Machining by Laser and its other applications: Electrons Beam action, Process controls, and applications.

Special Methods: Plasma Arc machining and Ion Implantation. High Velocity Forming of Metals, Explosive forming principles and various applications**.**

Books Recommended

1. Mishra P K, *"Non-Conventional Machining"* Narosa Publishing House, New Delhi (1997).
2. Panday P C and Shan H S, *"Modern Machining Processes"* 5th reprint, Tata Mc Graw Hill, New Delhi (1998).
3. Ghosh Amitabha and Malik A K "*Manufacturing Science"* East West Publication, New Delhi (1985).

4. Code No. 244 *"Non Traditional Machining Processes"* All India Council for Technical Education (CEP) Bangalore (October 1992).
5. Code No. 308 *"Advance Machining Process"* All India Council for Technical Education (CEP) Bangalore.

MEPE-430	Vibro-Acoustics	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

Detailed Syllabus

Introduction to Engineering acoustics, wave approach to sound, noise measurement and instrumentation standards, sound pressure, power and intensity, noise radiation from vibrating bodies, single degree of freedom system (SDOF), multiple degree of freedom system (MDOF) vibration in longitudinal bars, fluid structure-acoustic interaction, airborne sound, quantification of sound, random vibrations, flexural vibration of beams, plates and shells, sound sources, room acoustics, sound structure, statistical energy analysis(SEA), Introduction about experimental modal analysis, finite element method approach to predict the mode shapes of a beam, plate or a three dimensional vibro-acoustic cavity.

Books Recommended:

1. M. C. Junger, D. Feit, Sound, Structures and Their Interaction, The MIT Press (December 30, 1972).
2. F. J. Fahy, Sound and Structural Vibration: Radiation, Transmission and Response, cademic Press (January 28, 1987).
3. L. Cremer, M. Heckl, B.A.T. Petersson, Structure-Borne Sound: Structural Vibrations and Sound Radiation at Audio Frequencies, Springer, 3rd ed. edition (March 14, 2005).
4. R. H. Lyon, R. G. Dejong, Theory and Application of Statistical Energy Analysis, R.H. Lyon Corp (January 1, 1995).
5. R.H. Lyon, Machinery Noise and Diagnostics. Boston:Butterworths (1986)
6. E. Skudrzyk, Simple and Complex Vibratory Systems (Hardcover), Univ of Pennsylvania Press (June 1968).

MEPE-431	Welding and Allied Processes	DepartmentElective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO1	Understanding of the basic fundamentals of joining technolgy andhave a knowledge of various joining processes.
CO2	To attain the knowledge of different power sources used along with the VI characteristics.
CO3	To understand the chemistry of fluxes, its reactions to the molten metal and various consumables used in welding/ joining technology.
CO4	To attain the knowledge of various joining processes, their application, advantages and limitations.

Detailed Syllabus

Introduction: Introduction to joining technology, General survey and classification of welding processes, Safety and hazards in welding, Physics of the welding arc and arc characteristics, Metal transfer & its importance in arc welding, Various forces acting on a molten droplet and melting rates,

Power sources for arc welding: Power sources for arc welding, classification of power sources, characteristic curves

Welding consumables: Fluxes, gases and filler materials for various welding processes.

WeldingProcesses and their Applications: SMAW, SAW, GTAW and related processes, GMAW and variants, PAW, Gas welding, Soldering, Brazing and diffusion bonding, Thermal cutting of metals, Surfacing and spraying of metals, Resistance welding processes: spot, seam, butt, flash, projection, percussion etc, Thermit welding, Electro-slag and electro-gas welding, Solid-state and radiant energy welding processes such as EBW; LBW; USW, Explosive welding; Friction welding etc, Welding of plastics, Advances, challenges and bottlenecks in welding.

Books Recommended

1. Lancaster J F, “The Physics of Welding”, Pergamon Press (1984)
2. Little R F, “Welding and Welding Technology”, Mc Graw Hill Co (2001)
3. Nadkarni S V, “Modern Arc Welding Technology”, Ador Welding Ltd (2008)
4. Davies A C, “Welding”, Cambridge University press, (2005)

MEMI-201	Thermo-Fluidics	Minor Elective	L	T	P	Credit
			3	0	0	3

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

CO 1	Apply mass, momentum, energy and entropy balances to compressible flow and use compressible flow tables and relations to solve problems involving compressible flow in a nozzle and diffuser.
CO 2	Apply the principles of thermodynamics to evaluate the performance of Rotary, Centrifugal and Axial Air compressors,
CO 3	To enable the students to understand the physics of different modes of heat transfer and importance of the subject of heat transfer in day to day life and in engineering applications.

Thermodynamics

Basics: Laws of thermodynamics, Carnot Cycle, Concept of available energy, Exergy analysis, Entropy, Pure substances, Thermodynamic property relations, Properties of mixtures, Fuel and Combustion.

Working Cycles:Simple Rankine cycle, Binary vapour cycle, Vapor compression cycle, Air standard cycles, methods of improving efficiency of the cycles, combined power and heating cycles,

Fluid Mechanics

Fluid Statics:Hydrostatic Forces on Plane Surfaces, Hydrostatic Forces on Curved Surfaces, Pressure Distribution in Rigid-Body Motion

Fluid Kinematics:Differential Equation for Conservation of Mass, Linear Momentum, Angular Momentum and Energy. Streamlines, Streaklines, Pathlines and Timelines Reynolds Transport Theorem and its transformation into differential conservation equations, The Bernoulli Equation, Navier-Stokes equation of motion, Simplified solutions of Navier Stokes equation, Flow through pipes, Minor Losses in Pipe Systems, Multiple-Pipe Systems, Flow losses in pipes, Darcy equation for head loss due to friction, Fluid Meters. Salient features of flow pattern in a boundary layer, Velocity and shear stress distribution along the boundary, similarity solutions, Von-Karman momentum integral equation, flow over a curved surface, boundary layer separation and its control.

Heat Transfer

Conduction:Fourier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Three- dimensional general heat conduction equation in rectangular, cylindrical and spherical coordinates. Solutions of simple one dimensional steady state heat conduction problems with electrical analogy of the heat transfer, Introduction to unsteady heat transfer, Newtonian heating and cooling of solids; Analysis of single fin and array of fins, fin effectiveness and fin efficiency.

Convection:Free and forced convection, derivation of three dimensional mass, momentum and energy conservation equations (with introduction to Tensor notations). Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Theory of dimensional analysis as applied to free and forced convective heat transfer, Boiling and Condensation, Nucleation and different theories of nucleation.

Radiation:Fundamentals of thermal radiation, basic laws governing thermal radiation process, Intensity of Radiation, radiation density, irradiation, radiosity and radiation shields, radiation exchange and enclosure analysis.

Books Recommended

1. Yunus A. Cengel, Michael A. Boles, "**Thermodynamics: An Engineering Approach**", by Tata McGraw-Hill.
2. Gordon J. Van Wylen, Richard E. Sonntag, "**Fundamentals of Classical Thermodynamics**", by John Wiley & Sons.
3. Nag, P.K., "**Engineering Thermodynamics**", by McGraw-Hill Education.
4. Çengel, Y.A. and J.M. Cimbala, "**Fluid Mechanics"**, McGraw-Hill, Boston, MA.
5. White, F. M., "**Fluid Mechanics"**, McGraw Hill.
6. White, F. M., "**Viscous Fluid Flow"**, McGraw Hill.
7. Kundu, P. K., and Ira M. Cohen, "**Fluid Mechanics"**, 4th ed., Academic Press, 2007/Elsevier, 2008. ISBN-10: 0123737354, ISBN-13: 978-0123737359.
8. Theodore L. Bergman, Frank P. Incropera, David P. DeWitt, Adrienne S. Lavine, "**Fundamentals of Heat and Mass Transfer**", John Wiley & Sons, 2012.
9. Çengel, Y.A., "**Heat and Mass Transfer- A Practical Approach"**, McGraw-Hill, Boston, MA.
10. Holman J P, "**Heat Transfer**", McGraw Hill Book Company (1997).

MEMI-202	Strength of Materials	Minor Elective	L	T	P	Credit
			3	0	0	3

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

CO 1	To establish an understanding of the fundamental concepts of mechanics of deformable solids.
CO 2	To provide students with exposure to the systematic methods for solving engineering problems in solid mechanics.
CO 3	To understand the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear and combined loading.
CO 4	To build necessary theoretical background for further structural analysis and design course.

Stresses and strains: Fundamental of Stress and strain, stress-strain relationship and elastic constants, principal stresses and principal planes, Mohr's circle for plane stress and plane strain, thermal stresses.

Bending moment and shear force diagrams: For cantilevers, simply supported and fixed beams with or without overhangs and calculation of maximum BM and SF.

Bending and shear stresses in Beam: Simple bending theory, derivation of formula for Bending and shear stresses, its application to beams. Distribution of Shear Stress in beam of crosssection: rectangular, triangular, I, C, T, L, circular and hollow sections.

Slope and deflection in Beam: Relationship between moment, slope and deflection, Moment area method, Macualay's method.

Bending Stress in curved beams: Derivation of bending Stress in curved beams: crane or chain hooks, rings of circular section and trapezoidal section and chain links with straight sides, Deflection of curved bars and rings.

Torsion: Derivation of torsion equation, it's application hollow and solid circular shafts.

Springs: Closed and open coiled helical springs: Derivation of formula and application for deflection and rotation of free end under the action of axial load and or axial couple; flat spiral springs – derivation of formula for strain energy, maximum stress and rotation. Leaf spring, deflection and bending stresses.

Thin cylinders and spheres: Derivation of formulae and calculations of hoop stress longitudinal stress in a cylinder, and sphere subjected to internal pressures increase in Diameter and volume.

Thick Cylinders: Derivation of Lame's equations, calculation of radial longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts.
Columns and struts: Columns under uni-axial load, Buckling of Columns, Slenderness ratio and conditions. Derivations of Euler's formula for elastic buckling load, equivalent length, Rankine Gordon's empirical formula.

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum strain energy theory, maximum shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems only.
Rotational stresses: Discs and rims, discs of uniform strength.

Books Recommended

1. Timoshenko, S P, James M and Gere, "Mechanics of Materials", 2nd Edition, CBS Publishers, New Delhi (1998).
2. Boresi A P, Schmidt R J and Sidebottom O M, "Advanced Mechanics of Materials", John Wiley and sons Inc, New York (1993).
3. Ferdinand P. Beer, E. Russell Johnston Jr., John T. Dewolf,, David F. Mazurek, Sanjeev Sanghi, "Mechanics of Materials", 7th Edition, Mcgraw Hill (2016)
4. Ryder GH, "Strength of Materials", 3rd Edition English Language Book Society / Macmillan Hongkong (2002).
5. Hibbeler, Russel C, "Mechanics of Materials", 4th Edition, Prentice Hall (2000).
6. Dieter G.E. "Mechanical Metallurgy", McGraw Hill, New York (1996).

MEMI-301	Applied Thermal Engineering	Minor Elective	L	T	P	Credit
			3	0	0	3

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

CO 1	To review thermodynamics and thermal systems engineering and develop understanding of vapor compression and heat-driven refrigeration systems.
CO 2	To understand the components of vapour compression refrigeration system.
CO 3	To develop familiarity with refrigerants from the performance and environment

	point of view.
CO 4	Learn to classify different types of internal combustion engines and their applications, Demonstrate a basic understanding of engine function, performance, fuels for IC engines and design methodology.
CO 5	Analyze thermodynamic cycles for Otto, Diesel cycles, striling, Carnot and duel cycle, Given an engine design specification, predict performance and fuel economy trends with good accuracy.
CO 6	Determine and understand the effects of spark timing, valve timing, A/F ratio, engine geometry, fuel type, and manifold tuning on engine performance and emissions, Understanding of the performance and emission analysis of internal combustion engine and after treatment devices.

Refrigeration and Air Conditioning:

Natural and Mechanical Refrigeration, Application of refrigeration, Bell Coleman Cycle and its analysis; Vapour compression cycle and its analysis, Vapour Compression Refrigeration with Multiple Evaporators and Compressors, Principle of absorption system and its components, Lithium Bromide–water absorption system, Comparison between absorption and compression system, Classification and nomenclature of refrigerants, Desirable thermodynamic, chemical and physical properties of refrigerants, comparative study of commonly used refrigerants and their fields of application; Brief description of compressors, condensers and evaporators and expansion devices, Cooling towers. Concept and Applicationsof Air Conditioning, Psychometric properties of air, psychometric chart, Human requirements of comforts and comfort charts, Industrial air conditioning.

Internal Combustion Engines

Classification and Nomenclature, Applications of IC Engines, Review of Air standard cycles: Working of 4 stroke SI and CI Engines and their valve timing diagram, working of 2-stroke SI and CI engines and their valve timing diagrams, Comparison of two stroke and four stroke Engines, Fuel Air Cycles and their analysis, Requirements of fuel in I C engines, Type of Fuels- Solid, Liquid and Gaseous fuels, Combustion of Fuels and its analysis, fuel injection systems of IC engines, Stages of Combustion in SI and CI Engines, factors effecting the combustion process, knocking and detonation, Purpose of supercharging its types and analysis, limitations of supercharging. Performance testing of IC engines, Emission of various pollutants from the engines and Exhaust gas treatment.

Books Recommended

1. Arora C P, "**Refrigeration and Air Conditioning**", 19th Edition, Tata McGraw Hill, Delhi (1985).
2. Pradad M, "**Refrigeration and Air Conditioning**", 2nd Edition, New Age International Private Limited, Delhi (2002).
3. Dossat, R J, "**Principles of Refrigeration**", 4th Edition, Pearson Education (Singapore), India, (2002).
4. Mcquiston F G, Parker J D and Spilter J D, "**Heating, Ventilating, and Air Conditioning**", 5th Edition, John Wiley and Sons Inc, New York (2001).
5. Jordan and Priester, "**Refrigeration and Air Conditioning**", Prentice Hall of India (1998).

6. Ananthanarayan, "**Basic Refrigeration and Air Conditioning**",3rd Edition, Tata McGraw Hill
7. Heywood J B, "**Internal Combustion Engine Fundamentals**", McGraw Hill, Publication, New Delhi (1988).
8. Taylor C F, "**The Internal Combustion in Theory and Practice**", Volume I and II, MIT Press, Cambridge, Mass (1968).
9. Pulk Rabek W W, "**Engineering Fundamentals of Internal Combustion Engine**", Pearson Education, New Delhi (2003).
10. Stone R, "**Introduction to Internal Combustion Engines**", 2nd Edition, Macmillan (1993).
11. Milton B E, "**Thermodynamics, Combustion and Engines**", Champman and Hall (1995)

MEMI-302	Theory of Machines	Minor Elective	L	T	P	Credit
			3	0	0	3

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

CO 1	Understand the concepts of machines, mechanisms and related terminologies.
CO 2	Analyze planar mechanism for displacement, velocity and acceleration graphically.
CO 3	Analyze various motion transmission elements like gears, gear trains, cams, belt drives and rope drives.
CO 4	Utilize analytical, mathematical and graphical aspects of kinematics of machines for effective design.
CO 5	Perform the kinematic analysis of a given mechanism.

Basic Concepts: Kinematics of machine, Kinematic link and their different types, types of kinematic pair, kinematic chain, mechanism and inversions of four bar chain and slider crank mechanism. Degree of freedom, synthesis of linkages – number synthesis, Grashof's criterion and introduction to dimensional synthesis.

Velocity Analysis: Motion of a link, velocity of a point on a link by relative velocity method, velocities of slider crank mechanisms, rubbing velocity at a pin joint, velocity of a point on a link by instantaneous center method, properties and types of I-Center, Kennedy theorem and methods of locating I-centers in a mechanism.

Acceleration Analysis: Acceleration of a point on a link, acceleration in slider crank mechanism

Cams and Follower: Types of cams and followers, cam terminology, types of motion of the follower, analysis of motion of the follower, analysis of motion of the follower for cams with specified contours.

Gears: Classification of gears, terminology used in gears, law of gearing, velocity of sliding, forms of teeth, construction and properties of an involute, construction and properties of cycloidal teeth, effect of variation of center distance on the velocity ratio of involute profile tooth gears, length of path of contact, arc of contact, number of pairs of teeth in contact,

interference, minimum number of teeth, interference between rack and pinion, undercutting, terminology of helical and worm gears.

Gear Trains: Definition of simple, compound, reverted and epicyclic gear trains, velocity ratio of epicyclic gear trains.

Belt, Rope and Chain Drive: Types of belt drives, velocity ratio, law of belting, length of belt, ratio of friction tensions, power transmitted, effect of centrifugal tension on power transmission, condition for maximum power transmission, concept of slip and creep. Chain drive, chain length and angular speed ratio.

Brakes and Dynamometers: Types of brakes, principle and function of various types of brakes, problems to determine braking capacity, different types of dynamometers.

Static Force Analysis: Static equilibrium, equilibrium of two-force and three-force members, members with two forces and a torque, free body diagram, principle of virtual work, friction in mechanisms.

Balancing: Static and dynamic balancing, balancing of several masses in different planes, Balancing of reciprocating masses, balancing of locomotive, partial balancing, direct and reverse crank method, balancing of inline engines and V-Engines, balancing machines.

Lower Pairs: Pantograph, straight line mechanisms, engine indicators, automobile steering gears, Hooke's joint and double Hooke's joint.

Flywheels: Turning moment diagram for steam engine and four-stroke internal combustion engine and for multicylinder engines, fluctuation of energy and speed in flywheels, size of flywheel and flywheel for punching press.

Books Recommended

1. Bevan T, "The Theory of Machines", 3rd Edition CBS Publishers and Distributors (2002).
2. Shigley J E and Vickar J J, "Theory of Machines and Mechanism", 2nd Edition, McGraw Hill, New Delhi (1995).
3. Wilson C and Sadler J, "Kinematics and Dynamics of Machine", 3rd Edition, Prentice Hall (2002).
4. Ratan S S, "Theory of Machines", 1st Edition, Tata McGraw Hill, New Delhi (1993).
5. Rao J S and Dukkipati R V, "Mechanism and Machine Theory", 2nd Edition, New Age International (P) Limited, Delhi (1992).

MEMI-401	Fluid Machines	Minor Elective	L	T	P	Credit
			3	0	0	3

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

CO 1	Study of hydraulic turbines like Pelton, Francis and Kaplan turbines including their performance analysis, cavitations in turbines, similarity analysis.
CO 2	Study of different types of pumps like centrifugal pumps and reciprocating pumps, including its performance analysis.
CO 3	Apply the principles of thermodynamics to evaluate the performance of Rotary, Centrifugal and Axial Air compressors
CO 4	Study the main elements and their functioning of pumps.

General Concepts: Basic components of a turbomachine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid , Euler's equation for energy transfer in a turbomachine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes. Impulse momentum principle, calculations for force exerted, work done and efficiency of jet.

Power Turbines:
Steam Turbines **:** Classification; Impulse & Reaction Steam turbines, description of components , Pressure and velocity compounding, Velocity diagram and work done, Effect of blade friction on velocity diagram, Stage efficiency and overall efficiency, Reheat factor and condition curve. Degree of reaction, blade efficiency and its derivation; calculation of blade height, backpressure and extraction turbines and cogeneration; losses in steam turbines, Governing of steam Turbines.

*Gas Turbines:*Classification, Open and closed cycle and their comparison. Application of gas turbine.Position of gas turbine in power industry.Thermodynamic analysis-Brayton cycle, calculation of net output, work ratio, and thermal efficiency, Operating variables and their effects on thermal efficiency and work ratio.Gas turbine cycle with regeneration, inter-cooling, multistage compression and expansion. Closed and semi closed gas turbine cycle.

*HydraulicTurbines:*Components and its operation, velocity triangles for different runners, work output, Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions. Francis and Kaplan Turbines: Components and operation, velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction, draft tubes – its function and types. Function and brief description of commonly used surge tanks.

Air Compressors:
Use of compressed air in industry, Classification of air compressors, Operation of single stage reciprocating compressors, Work input and the best value of index of compression, Effect of clearance and volumetric efficiency,Classification of rotary compressors, comparison with reciprocating compressors, working of rotary compressors and determination of total work done for compressors, energy loss in internal friction, Thermodynamic analysis of centrifugal compressor, velocity vector diagrams for centrifugal compressors, power calculation, Degree of reaction and its derivation, Derivation of Non-dimensional parameters for plotting compressor characteristics, surging and choking in centrifugal compressors, Components of axial flow compressor, velocity vector diagrams, thermodynamic analysis and power calculations, Stalling in axial flow compressors, characteristic curves for axial flow compressor.

Pumps:
Layout and installationof Centrifugal Pumps; Main elements and their functions, Various types and classification, pump output and efficiency, Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps, Axial and mixed flow pumps, Performance Characteristics: Unit quantities, specific speed and model relationships, scale effect, cavitation and Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting,Components parts and workingof Reciprocating Pumps, pressure variations due to piston acceleration, acceleration effects in suction and delivery pipes, work done against friction, maximum permissible vacuum during suction stroke, Air vessels.

Books Recommended

1. D.S. Kumar, "**Engineering Thermodynamics**", Publisher: S.K. Kataria & Sons; Reprint 2013 edition (2012).
2. R. Yadav, "**Applied Thermodynamics**" Central Pub House-Allahabad (2011).
3. Mahesh Rathore, "**Thermal Engineering**" McGraw Hill Education; 1 edition (5 April 2010).
4. H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen, Paul Straznicky, "**Gas Turbine Theory**", Pearson Education Canada; 6th edition (September 1, 2008) (7th Edition).
5. P R Khajuria, S P Dubey, "**Gas Turbines And Propulsive Systems**", Dhanpat Rai Publications.
6. S.M Yahya, "**Turbines, Compressors and Fans**", McGraw Hill Education; 4 edition (1 July 2017).
7. Daughaty R L, **"Hydraulic Turbines**", McGraw Hill Book Company (1965).
8. Jagdish Lal, "**Hydraulic Machines**", Metropolitan Book Company Private Limited, New Delhi, (2000).
9. Stepanoff A J, "**Centrifugal and Axial Flow Pumps**", John Wiley and Sons (1970).
10. Binder R C, "**Advanced Fluid Mechanics and Fluid Machinery**", Prentice Hall (1966).
11. Nechleba M, "**Hydraulic Turbine**", Constable and Company (1957).
12. S.K. Som, Gautam Biswas, "**Introduction to Fluid Mechanics and Fluid Machines**" Publisher : McGraw Hills.

MEMI-402	Design of Machine Elements	Minor Elective	L	T	P	Credit
			3	0	0	3

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

CO 1	Analysis of Selection of materials for different mechanical component.
CO 2	Use the knowledge of other subject like mathematics, science and material science for designing purpose.
CO 3	Design the individual component for the mechanical system.
CO 4	Practical approach for designing and analysis of component of machine.

Introduction of Design with special reference to machine Design, Design process.

Various considerations required for design of a component:. Selection of materials, mechanical behavior of materials, Stress concentration, factor of safety under different loading conditions, design stresses for variable and repeated loads, endurance limit, fatigue strength, limited life. Fits, tolerances and surface finish.

Fasteners and joints: Bolts, preloaded bolts subjected to shear, and torsion. Bolted, Welded and Riveted joints, eccentrically loaded welded and riveted joints, Cotter and cotter joints, pin fasteners, Knuckle joints.

Transmission shafts: Design of shaft subjected to static loading: pure torsion, simple bending, combined bending and torsion, combined bending torsion and axial loads.

Keys: Different types of keys and splines, representations and use in Couplings.

Rigid couplings: Sleeve couplings, Flange couplings, Flexible couplings: Bush pin type, Universal type.

Levers: Hand and foot levers, cranked lever.

Brakes and Clutches: Brakes: Design consideration of brakes, Flat plate, and conical plate clutches.
IC engine parts: Cranks, flywheels, piston.

Gears: Different types of gears, Spur, Helical, Bevel.

Books Recommended

1. Norton L R, "Machine Design an Integrated Approach", Pearson Education Asia, Ist Indian Reprint (2001).
2. Sharma P C and Aggrawal D K, "A text book on Machine Design", S K Kataria & sons, 9th Edition (2000).
3. Bhonsle R S and Weinmann J K, "Mathematical modeling for Design of Machine Components", TK Integrated, Prentice Hall (1999).
4. Spotts M F and Shoup T E, "Design of Machine Elements", Prentice Hall Seventh Edition (1998).
5. Shigley J E and Mischke C R, "Mechanical Engineering Design", Tata Mcgraw Hill, New Delhi (2003).

MEOE-351	Mechanics of Composite Material	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Ability to analyze: anisotropic material for stress-strain i.e., to determine stiffness and compliance matrix, Macro mechanics of continuous fiber-reinforced lamina, and Multi axial theory of failure for fiber reinforced composite materials, understand the classical lamination theory, A-B-D matrix and design laminated composite structure economically thereafter.
CO 2	An ability to analyze FRP using micromechanical methods such as mechanics of material, semi empirical, and elasticity approach.
CO 3	Basic understanding of: Modeling of Discontinuous fiber reinforced composites, Hygrothermal analysis of composite lamina and laminates, and Viscoelastic behavior of fiber reinforced composites.
CO 4	Study of mechanical testing of the constituent and the elastic moduli, viscoelastic and dynamic properties of composites.
CO 5	Enable the students to independently analyze and extend a given course subject, compose a report paper and effectively communicate the essentials through an oral presentation.

Detailed Syllabus

Introduction: Basic concepts and definitions, constituent materials, applications and fabrication process related to composite materials.

Macromechanics: Lamina stress-strain relation, anistropic behaviour, engineering contents, stiffness and compliance matrices, transformed matrices and invariants. Analysis of laminates, classification of laminates, laminated beams. Laminated plates, theory of laminated plates with coupling, stiffness characteristics of related laminates, laminate compliances, lamina and laminate stresses and strains, and laminate engineering constants.Introduction to interlaminar stresses, laminate strength and failure analysis.

Micromechanics: Continuous fiber-reinforced lamina, prediction of elastic moduli by mechanics of material, elasticity and semi-empirical models and model for prediction of lamina strength. Discontinuous fiber-reinforced lamina, elastic moduli and stress-strain relationship.

Mechanical Testing: Measurement of constituents i.e., fiber and matrix, measurement of elastic moduli, viscoelastic and dynamic properties of composites.

Books Recommended

1. Jones R M, *"Mechanics of Composite Materials",* Scripta Book Company (1975).
2. Herkovic C T, *"Mechanics of Fibres Composites",* University of Virginia, John Wiley and Sons, Inc (1998).
3. Tsai Stephen W, *"Introduction to Composite Materials"*, Technomic Publishing Company Inc (1980).
4. Gibson R F, *"Principles of Composites Materials Mechanics"*, McGraw Hill International Edition, New York (1994).

5. Hyer M W, *"Stress analysis of Fiber-Reinforced Composites Materials"*, WCB McGraw Hill, Boston (1997).

MEOE-352	Occupational Safety and Environment	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Develop a broad base knowledge in science. Apply knowledge to anticipate, recognize, and quantify agents, factors, and stressors generated by and/or associated with defined sources, unit operations, environmental processes, & work tasks.
CO 2	Develop an ability to analyse, evaluate, management systems and programs to prevent hazardous acts and conditions that lead to loss events. The programs will include cost/benefit analysis, training programs, etc.; Develop and evaluate appropriate strategies designed to mitigate risk.
CO 3	Evaluate and recommend engineering, administrative, and personal protective equipment controls or other interventions to reduce or eliminate hazards; Recognize important professional, ethical, social, cultural, global, and current issues impacting worker health and the environment.
CO 4	Interpret and apply current applicable occupational and environmental regulations; Participate as a team player in the development of scientific reports, and technical summaries; Effectively communicate verbally and in writing using computers and state of the art media; and Recognize the importance of continuous and ongoing learning.

Detailed Syllabus

Safety: Meaning & need for safety. Relationship of safety with plant design, equipment design and work environment. Industrial accidents, their nature, types and causes.ssessment of accident costs; prevention of accidents. Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis.Safety and economics, safety and productivity.Employees participation in safety. Safety legislation.

Environment: Environmental factors in industry. Effect of temperature, Illumination, humidity noise and vibrations on human body and mind.Physiology of heat regulation.Thermal environment and its measurement.Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation.Mechanical ventilation.Air conditioning Process ventilation. Control of heat exposures, control at source, insulation, and local exhaust ventilation. Control of radiant heat, dilution ventilation.Local relief.

Industrial Lighting: Purpose of lighting, benefits of good illumination. Phenomenon of lighting and safety.Lighting and the work.Sources and types of artificial lighting.Principles of good illumination.Recommended optimum standards of illumination.Design of lighting installation.

Noise and Vibrations: Continuous and impulse noise. The effect of noise on man.Noise measurement and evaluation of noise.Noise isolation.Noise absorption techniques. Silencers vibrations: Effect, measurement and control measures. Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work.

Books Recommended

1. Krishnan N V, *"Safety management in Industry",* Jaico Publishing House, Delhi (1993).
2. Kocurek Dianna and Woodside Gayle, *"Environment, Safety, and Health Engineering"*, John Wiley and Sons, New York (1997).
3. McCormick J, *"Human Factors in Engineering and Design"*, Tata McGraw Hill Publishing Company Limited, New Delhi (1979).
4. Willie Hammer, Dennis Price, "Occupational Safety Management and Engineering", 5th Ed., Pearson Education (2000).
5. David Goetsch, "The Safety and Health Handbook", Pearson Education (1999).

MEOE-353	Operation Management	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO 1	Analysis of System concepts: Classification of systems Organizations as systems.
CO 2	Definition, objectives, functions and scope of operations management.
CO 3	Industrial management – relationship of operations management with the areas of industrial management.
CO 4	Types of productive systems and their characteristic features – Continuous and intermittent systems.
CO 5	Decision making in production systems: Scientific process Characteristics of decisions Framework for decision making.

Detailed Syllabus

Operations Management: Introduction, Historical Evolution of Production and Operations Management, Trends in Operation Management, Production and Operations management as a Career, Operation strategies for competitive advantages, Productivity and Quality, Technology and Mechanization.

Production Planning and Control: Forecasting, Capacity Planning, Layout Planning, Location Analysis, Plant Layout and Materials Handling.

Product Design and Development: Steps involved in Product design and development, Factors affecting Project Design and Development like ergonomics, aesthetic, economic, technical. Case studies.

Materials Management and Inventory Control: Inventory concepts, Scope, function and objectives of Inventory, Inventory costs, Determination of E.O.Q., ERP, MRP-I, MRP-II, Just in time, Concept of Zero Inventory.

Quality Control: Meaning of Quality Control and its Impact, Functions of Quality Control, Introduction to SQC, Japanese Contribution to Quality Control, Managing Quality, Introductory Concept of Six Sigma, Introduction to ISO 9000 and 14000, Specific Case Studies.

MIS: Introduction to Management Information system, Steps involved in designing an MIS, Role and Application of Computers in MIS, Case studies.
Project Management: Project planning, Project scheduling models, Managing the project, Work breakdown structure, Progress reporting, Role of Human Behavior in project environment.

Books Recommended

1. Buffa and Sarin, *"Modern Production / Operation Management",* 8th Edition, John Wiley and Sons (1987).
1. Adam and Ebert, *"Production and Operations Management",* 5th Edition, Prentice Hall of India, New Delhi (2000).
2. Krajenski and Ritzman, *"Operations Management Strategy and Analysis'',* 6th Edition, Pearson Education, New Delhi (2002).
3. Mazda Fraidoon, *"Engineering Management",* 3rd Reprint, Pearson Education (2000).
4. Besterfiled, *"Total Quality Management",* Pearson Education (2003).

MEOE-354	Operations Research	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Illustrate the need to optimally utilize the resources in various types of industries.
CO 2	Apply and analyze mathematical optimization functions to various applications.
CO 3	Demonstrate cost effective strategies in various applications in industry.

Detailed Syllabus

Overview: Introduction**,** Definition, characteristics and scope of O.R., Objectives of O.R., Phases and models in O.R.

Linear Programming: Introduction, Concept of linear programming, Graphical method, Simplex method, Big M method, Dual simplex method, Two-phase method, Duality in linear programming.

Transportation Problem: Introduction, Mathematical models for T.P., Formulation and solution of balanced and unbalanced T.P., Trans shipment models.

Assignment Models: Definition, Comparison with transportation model, Mathematical representation of assignment models, Formulation and solution of assignment models, Variations of the assignment problem and alternate optimal solutions.

Sequencing Models: Processing n jobs through two machines, processing n jobs through three machines, processing two jobs through m machines, processing n jobs through m machines, Travelling salesman problem.

Inventory Control: Purchase model with instantaneous replenishment and with and without shortages, Manufacturing model with and without shortages, Quantity discount.
Queueing Theory: Introduction, Terminologies of queueing system, Empirical queueing models.

Replacement Models: Replacement of items that deteriorate with time, Replacement of items that fail suddenly, Individual and group replacement.

Game Theory: Introduction and terminologies of game theory, games with pure and mixed strategies.

CPM and PERT: Basics steps in PERT and CPM, PERT and CPM computations, Cost analysis, Contracting and Updating, Resource Scheduling.

Books Recommended:

1. Panneerselvam R, "*Operations Research*", PHI, 2002.
2. Tulsian P.C., Pandey Vishal, "*Quantitative Techniques*", Pearson Education, 2002.
3. Wagner, "*Principles of Operations Research*", Prentice-Hall India, 2000.

MEOE-355	Product Design and Development	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: Design of Machine Elements (MEX-301).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Understand the product design and development process, product planning and concept generation.
CO 2	Understand the Design for Manufacturing, prototyping and Robust Design and product architecture

Detailed Syllabus

Introduction-Introduction to product design, Significance of product design, product design and development process, sequential Engineering design method, the challenges of product development, Development Process and Organizations-Generic Development Process, Concept Development, Adapting the generic PD process flows, AMF development Process, Product Development Organizations, The AMF Organization.

Product Planning and Identifying Customer Needs-Product Planning process, Interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance of needs, review of the process. Product Specifications-Establish target specifications, setting final specifications.

Concept Generation-Activities of concept generation, clarifying problem, search both internally and externally, explore the output,

Concept Selection-Overview, concept screening and concept scoring, methods of selection.

Concept Testing-Elements of testing: qualitative and quantitative methods including survey, measurement of customers' response.

Product Architecture-Modular & Integral architecture, implications, establishing the architecture, Delayed differentiation, Platform Planning.

Industrial Design-Assessing need for industrial design, Impact of industrial Design, Industrial design process, management of industrial design process, assessing quality of industrial design.
Embodiment Design: Design for Manufacturing, prototyping. Robust Design. Intellectual Property and Environmental Guidelines-Intellectual Property: Elements and outline, patenting procedures, claim procedure, Environmental regulations from government, ISO system.

Books Recommended:
1. Ulrich K. T, and Eppinger S. D, Product Design and Development, Tata McGraw Hill
2. Otto K, and Wood K, Product Design, Pearson
3. Engineering of creativity: introduction to TRIZ methodology of inventive Problem Solving, By Semyon D. Savransky, CRC Press

MEOE-356	Production Management	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None.
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Understand the core features of the operations and production management function at the operational and strategic levels specifically the relationships between people, process, technology, productivity and quality improve an organizations performance.
CO 2	Develop an integrated framework for strategic thinking and decision making to analyze the enterprise as a whole with a specific focus on the wealth creation processes.
CO 3	Able to communicate effectively through discussion in seminars, teamwork and writing in discussion board, and a project report by gather evidence, data and information to make decisions.
CO 4	Utilize Tools viz. Value analysis, TPM and their contribution towards current production and operations management.

Detailed Syllabus

Introduction: Definition and scope of industrial engineering, Role of industrial engineer in industry. Qualities of an Industrial Engineer.

Work Study: Productivity and the standard of living, reducing work content and ineffective time, the human factor in the application of work-study, Working conditions and the working environment.

Method Study: Introduction of method study and the selection of jobs, Methods and movements at the workplace.

Work Measurement: Introduction, Work sampling, Time Study, equipment, timing the job, rating, Calculation of standard time, Setting time standard for works and machines, Predetermined time standards, Standard data and its use. Specific case studies.

Value Engineering: Types and concept of value engineering, phases of value engineering studies, application of value engineering.

Job Design: Traditional engineering dimensions of job design, Concepts of job enlargement, Job enrichment, Job rotation, effective job design in relation to technological and behaviour factors.

Ergonomics: Introduction, Considerations in designing man machine systems with special reference to the design of displays and control.

Maintenance Management: Introduction, types, total productive maintenance, condition monitoring.

Books Recommended:

1. Barnes M R, "*Motion and Time Study*", John Wiley and Sons (2002).
2. Oborne D J, *"Ergonomics at Work",* John Wiley and Sons (1985).
3. Miles, *"Techniques of Value Analysis and Engineering",* 2nd Edition, McGraw Hill (1997).
4. Ulrich Cart T and Eppinger Steven D, *"Product Design and Development",* Tata McGraw Hill, New Delhi (1995).
5. Hicks, *"Industrial Engineering and Management",* 2nd Edition, Tata McGraw Hill, New Delhi (1994).

MEOE-357	Production Planning and Control	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

CO 1	Apply the systems concept for the design of production and service systems
CO 2	Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
CO 3	Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources

Detailed Syllabus

Introduction: Definition of PPC, Concept of production planning and production control, objectives and functions of PPC, Comparison among production planning and production control, Information requirement for PPC, Manufacturing methods and PPC, Problems of PPC.

Function of PPC: Routing: concept, procedure, route sheet, routing in job order, Scheduling: objectives, factors affecting scheduling, master scheduling, production, Machine loading: objectives, adjustments, Dispatching: centralized and decentralized dispatching, Production Control: concept, objectives, progress reporting, correction actions, Types of Production Systems.

Forecasting Techniques: Concept and purpose of sales forecasting and production volume forecasting, Market Potential, Basic elements, Delphi methods, Moving average technique, Correlation analysis, linear regression analysis, Forecast error, Costs and accuracy of Forecasts.

Materials Management: Objectives, functions and types of materials management, organization and economic aspects of materials management, Buying Techniques, Purchasing Procedures and methods, inventory control, Economic Order Quantity, Inventory models, MRP: terminology, system, output, and logic, Break even analysis, Vendor rating, Outsourcing.

Process Planning: Framework for Process Engineering, Process and equipment selection, machine requirements, Machine outputs, Manpower planning, Combined Operations, Computer Aided Process Planning, Problems.

Supporting PPC Activities: Group Technology: group layout, stages, benefits and problems, Lean Manufacturing, Agile manufacturing, JIT, Supply Chain Management, Role of Database Management System in PPC, Lean Manufacturing, Enterprise Resource Planning.

Books Recommended:

1. Production Planning and Control: Samuel Eilon
2. Production and Operations Management: Adam Ebert
3. Production Planning & Inventory Control: Narsimhan

MEOE-451	Automobile Engineering	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Develop chassis and identify suitable engine for different applications and formulate steering, braking and suspension systems.
CO 2	Select a suitable conventional and automatic transmission system.
CO 3	Identify the usage of electrical and hybrid vehicles.
CO 4	Use of ANSYS software.

Detailed Syllabus

Introduction to Automobile: Importance, applications, job opportunities, classification, types of vehicles, Basic structure, general layout, hybrid vehicles.

Automotive Electric and Electronic Systems: Electric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles.

Automotive Drive Trains: Clutches, manual and automotive transmission and transaxles, drive shafts, universal joints, drive axles.

Automotive Chassis: Suspension system, steering system, wheel alignment, brakes, wheels and tyres.

Maintenance and Trouble Shooting: Automobile performance, drivability, emissions and emission norms, noise and vibration, engine tuning, equipment for measuring various vehicle parameters such as bhp, a/f ratio, noise, vibration and emission, comfort and safety.

Recent advances in automobiles and automotive components.

Books Recommended

1. Crouse W H and Anglin D N, *"Automotive Mechanics",* McGraw Hill, 10th Edition, Singapore (1993).
2. Bosch, *"Automotive Handbook",* SAE Publication (2000).
3. Tom Denton, *"Automobile Electrical and Electronics Systems",* Butterworth-Heinemann (2003).
4. Layne Ken, *"Automotive Engine Performance: Tune up, Testing and Service",* Englewood Prentice Hall of India (1986).
5. Tom Denton, *"Advanced Automobile Fault Diagnosis",* Butterworth-Heinemann (2002).

MEOE-452	Computational Fluid Dynamics	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

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

CO 1	To enable the students to understand different problem solving techniques theoretically and appreciate the importance of mathematics in engineering problem solutions.
CO 2	To illustrate different techniques to solve continuous formulations in differential form and transform them to discrete formulations using different discretization techniques like, FDM, FEM and FVM.
CO 3	To make students understand that FVM is most appropriate technique for developing discrete formulations and discuss the same technique in detail.
CO 4	To make students aware of different algorithms to solve numerically the fluid dynamics problems.
CO 5	To make students understand the utility of using commercial codes like, FLUENT and CFX and compare the competence of these codes with the dedicated codes written for engineering problems.

Detailed Syllabus

Review of basic fluid mechanics and the governing Navier-Stokes equations, Techniques for solution of PDEs – finite difference method, finite element method and finite volume method, Finite volume (FV) method in one-dimension, Differencing schemes, Steady and unsteady calculations, Boundary conditions, FV discretizationin two and three dimensions, Simple algorithm and flow field calculations, variants of SIMPLE, Turbulence and turbulence modeling, illustrative flow computations, Commercial softwares such as FLUENT and CFX – grid generation, flow prediction and post-processing.

Books Recommended:

1. S V Patankar, *Numerical Heat Transfer and Fluid Flow*, McGraw Hill, NY, (2005).
2. John Anderson, *Computational Fluid Dynamics*, McGraw-Hill Publication, 1st edition (February 1, 1995).
3. W M Kays and M E Crawford, *Convective Heat and Mass Transfer*, McGraw Hill, New York (1993).
4. F M White, *Viscous Fluid Flow* by, Mc-Graw Hill, New York, 2nd Ed. (1991).
5. Robert Siegel and John Howell, *Thermal radiation Heat Transfer*, 4th Ed., Taylor and Francis NY, (2002).

MEOE-453	Finite Element Methods	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO 1	Review the mathematical knowledge studied in previous semester.
CO 2	To understand the advantage of discreatization of the object.
CO 3	To develop familiarities with FEM software.
CO 4	To develop program for solving the problems.

Detailed Syllabus

Fundamentals of the Finite Element Method, discritization of the domain, one-two and three dimensional elements and interpolation functions, local and global coordinates, properties of interpolation functions, compatibility and completeness requirements, Assembly and boundary conditions; Formulation for FEM solutions.Application to solid mechanics, vibrations, plates and shell problems.

Books Recommended

1. Desai and Abel, *"Introduction to Finite Element Method",* East West, CBS Delhi (1987).
2. Zienkiewicz O C, *"Finite Element Method",* McGraw Hill (1989).
3. Krishnamurthy C J, *"Finite Element Method – Analysis Theory and Programming",* Tata McGraw Hill (1994).
4. Bathe k J, *"Finite Element Procedures",* Prentice Hall of India Private Limited, New Delhi, (1996).
5. Belegundu Ashok D and Chandrupatla T, *"Introduction to Finite Element Method",* PHI Private Limited, New Delhi (2003).

MEOE-454	Materials and Environment	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Understand the importance of materials and interrelationship between Materials, Energy, Emissions and Environment
CO 2	Carryout Life Cycle Assessment (LCA), Eco Audits using various methods
CO 3	Understand the importance of materials selection in the Mechanical Design process and use Material property charts, Material Indices for selecting materials for various types of mechanical systems
CO 4	Introduce the concept of Ecological Selection of Materials.

Detailed Syllabus

Introduction Material Dependence: Introduction and synopsis, Materials: a brief history, Learned dependency: the reliance on nonrenewable materials, Materials and the environment.

Resource Consumption & its drivers: Resource consumption, Exponential growth and doubling times, Reserves, the resource base, and resource life, Summary and conclusion.

The Materials Life Cycle: The material life cycle, Life-cycle assessment: details and difficulties, Streamlined LCA, The strategy for eco-selection of materials.

End of First Life- A Problem or a resource: What determines product life, End-of-first-life Options, The problem of packaging, Recycling: resurrecting materials.

Eco Data-Values, Sources, precision: Data precision- recalibrating expectations, The eco-attributes of materials, Energy and CO2 footprints of energy,transport, and use, Exploring the data: property charts.

Eco Audits & Eco Audit Tools: Introduction and synopsis, Eco-audits, Computer-aided eco-auditing, Case Studies.
Selection Strategies: Introduction, The selection strategy: choosing a car, Principles of materials selection, Selection criteria and property charts, Resolving conflicting objectives: tradeoff methods.

Eco-Informed Material Selection: Which bottle is best? Selection per unit of function, Crash barriers: matching choice to purpose, Deriving and using indices: materials for light, strong shells, Heating and cooling, Transport.

Sustainability- Living on Renewables: The ecological metaphor, Sustainable energy, sustainable materials, Future options.

Books Recommended:

1. Ashby M, "Materials & the Environment- Eco-Informed Material Choice" , Butterworth-Heinemann (2019)
2. Ashby M, "Materials and Sustainable Development", Butterworth-Heinemann (2016)
3. Ashby M, "Materials Selection in Mechanical Design", Third Edition, Elsevier, Indian Edition, (2005)
4. Ashby M and Johnson K, "Materials & Design, 2nd Edition- The Art & Science of Material Selection in Product Design", Butterworth-Heinemann (2009)

MEOE-455	Materials and Sustainable Development	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.

CO 1	Understand the importance of materials and interrelationship between Materials, Energy, Emissions and Environment
CO 2	Carryout Life Cycle Assessment (LCA), Eco Audits using various methods
CO 3	Understand the meaning and importance of sustainable development, assessment methods/techniques for sustainable development with various case studies
CO 4	Evaluate Materials supply chain risk and understand concept of CSR.

Detailed Syllabus

Introduction Material Dependence: Introduction and synopsis, Materials: a brief history, Learned dependency: the reliance on nonrenewable materials, Materials and the environment.

Resource Consumption & its drivers: Resource consumption, Exponential growth and doubling times, Reserves, the resource base, and resource life, Summary and conclusion.

The Materials Life Cycle: The material life cycle, Life-cycle assessment: details and difficulties, Streamlined LCA, The strategy for eco-selection of materials.

Eco Data-Values, Sources, precision: Data precision- recalibrating expectations, The eco-attributes of materials, Energy and CO2 footprints of energy,transport, and use, Exploring the data: property charts.

Eco Audits & Eco Audit Tools: Introduction and synopsis, Eco-audits, Computer-aided eco-auditing, Case Studies.

Sustainable Development: Introduction, Definitions, Triple Bottom Line Approach, Articulations of sustainable development, Assessing sustainable development, layered approach to assess sustainable development, Tools for assessment, Defining objective, stake holder analysis, fact finding, synthesis.

Materials Supply chain risk: Emerging constraints on materials sourcing and usage, price volatility risk, monopoly of supply and geo political risk, conflict risk, legislation & regulation risk, other risks.

Corporate Sustainability & materials: Introduction, Corporate social responsibility & sustainability reporting, Case Studies on Corporate SR's.

Case Studies on Sustainable development: Bioploymers to replace oil based plastics, Wind Farms, Electric Cars, Solar PV for Low Carbon power, Bamboo as sustainable building material.

Books Recommended:

5. Ashby M, "Materials and Sustainable Development", Butterworth-Heinemann (2016)
6. Ashby M, "Materials & the Environment- Eco-Informed Material Choice" , Butterworth Heinemann (2019)
7. Ashby M, "Materials Selection in Mechanical Design", Third Edition, Elsevier, Indian Edition, (2005)
8. Ashby M and Johnson K, "Materials & Design, 2nd Edition- The Art & Science of Material Selection in Product Design", Butterworth-Heinemann (2009)

MEOE-456	Metal Cutting and Machine Tools	Core Course	L	T	P	Credit
			3	0	0	3

Pre-requisites: Mechanical Measurement & Metrology (MEX-307).
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Apply cutting mechanics to metal machining based on cutting force and power consumption.
CO 2	Operate lathe, milling machines, drill press, grinding machines, etc.
CO 3	Students will be able to analyze cutting forces in turning, drilling and milling.
CO 4	Select appropriate machining processes and conditions for different metals.
CO 5	Students will be able to adjust varies parameters and reduce temperature developed during machining.
CO 6	Learn machine tool structures and machining economics. Students will be able to reduce the cost of machinery.
CO 7	Students will be able to prevent failures of cutting tool.
CO 8	Write simple CNC programs and conduct CNC machining.

Detailed Syllabus

Machining of Metals: Mechanics of metal cutting, Cutting Tool Nomenclature, Orthogonal and Oblique Cutting, Tool Angle Specification Systems, Effect of Cutting Parameters on

Tool Geometry, Temperature at the Shear Plane in orthogonal Cutting, Experimental Determination of Tool Temperature.

Tool Wear and Cutting Fluids: Cutting Fluids, Types of Cutting Fluids, Selection of Cutting Fluids, Methods of Applying Cutting Fluids, Kinds of Tool Damage, Tool Wear Equation, Tool Life Equations, Tool Life Tests.

General Purpose Machine Tools and Operations: Lathe and turning operations, Lathe and its accessories, Lathe specifications, lathe cutting tools, Classification of milling machines, specifications of milling machine, milling machine operations, indexing methods: simple and compound indexing. Shaper and Planes, Grinding Machines, Drilling Machines.

Introduction to new Machining Processes.

Mechanisms for rectilinear motion: Methods for producing rectilinear motion in machine tools, Rack and pinion drives, rotary and materials uses for pinions and racks, worm and rack drives, materials used, lead screw and nut drives, materials used for bad screws and nuts.

Structural Features of Machine Tools: Beds, Bases columns, material for beds, bases and columns typical constructions of beds, bases and columns, machine tool columns, Housings, Tables cross rails and carriages.

Frames and Guides: Sideways, Antifriction ways, circular ways.

Speed and Feed Gear Boxes: Speed gearboxes in machine tools, types of speed gearboxes, feed gearboxes, types of feed gearboxes.

Introduction to Numerical Control of Machine Tools.

Installation and maintenance of machine tools: Machine Tool installation and maintenance safety in machine tools, reconditioning of machine tools, trouble shooting.

Books Recommended

1. Devris W R, *"Analysis of Material Removal Processes"*, Springer – Verlag (1992).
2. Panday P C and Shan H S, *"Modern Machining Processes"*, Tata McGraw Hill Publishing Company Limited, New Delhi (1980).
3. Schey A John, *"Introduction to Manufacturing Processes"*, McGraw Hill Book Company, New York (1987).
4. HMT Bangalore, *"Production Technology"*, Tata McGraw Hill, New Delhi (1980).
5. Acherkan N, *"Machine Tool Design"*, Volume 1 to 4, MIR Publishers, Moscow (1969).

MEOE-457	Non-Conventional Energy	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	To make the students aware about the present energy scenario and importance of non conventional energy resources.
CO 2	To know about the various prevalent, non conventional energy resources and their respective worldwide with specific to India.
CO 3	To acquire the knowledge related to various energy conversion technologies, Direct and Indirect.
CO 4	To develop an ability for design and analysis of various energy conversion systems and devices.
CO 5	Introduce students to societal catalysts and challenges regarding renewable energy implementation.
CO 6	To enhance a student's ability to communicate in written form.

Detailed Syllabus

Wind Energy: Basic principle of wind energy conversion, wind data and energy estimation, site selection considerations, basic components of a WECS, classification of WECS system, application of wind energy.

Biomass Energy: Biomass conversion technologies, photosynthetic, biogas generation, factors affecting bio-digestion, classification of biogas plants with their advantages and disadvantages, types of biogas plants, constructional details of digesters, site selection for biogas plants, methods of obtaining energy from biomass.

Geothermal Energy: Nature of geothermal fields, types of geothermal sources. Advantages and disadvantages of geothermal energy over other energy forms, application of geothermal energy, geothermal energy prospects in India.

Energy from Ocean: Ocean thermal electric conversion, methods of ocean thermal elective power generation, energy from tides, basic principal of tidal power, components of tidal power plant, methods of utilization of tidal energy ocean waves and introduction and wave energy conversion devices.

Fuel Cell: Design and principle of operation of fuel cell, classification of fuel cells.

Magneto Hydrodynamic Power Generation: Principle of MHD power generation, types of MHD systems.

Thermo Electric Power: Basic principle of thermoelectric power generation, thermoelectric materials, selection of materials.

Thermionic Generation: Thermionic emission and work function, basic thermionic generator.

Hydrogen Energy: Hydrogen production, hydrogen storage and transportation, hydrogen as a alternative fuel for motor vehicles.

Books Recommended

1. Rai G D, *"Non-Conventional Energy Sources",* 4th Edition, Khanna Publishers, Delhi (1999).
2. Rao S and Paruleka B B, *"Energy Technology",* 1st Edition Khanna Publishers, Delhi (1999).
3. Abbasi S A and Abbasi Narsema, *"Renewable Energy Sources and their Environmental Impact",* Prentice Hall of India Private Limited, New Delhi (2001).
4. Kothari,D.P,Singal,K.C. & Ranjan, Rakesh, " Renewable Energy sources and Emerging Technologies", Ist Edition Prentice Hall of India(2008).

MEOE-458	Robotics: Mechanics and Control	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None

Course Assessment Method: Both continuous and semester end examination.

Topics to be covered: All.

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

CO 1	Understand the importance of robotics and its impact on human safety, quality of life, economy, environment.; basics of open ended type robotic manipulators.
CO 2	Understand the kinematics and dynamics of open ended robotic mechanism; Fixing frames using the Denavit-Hartenberg convention, Jacobian, singularity, Newton-Euler formulations for dynamics of rigid body systems.
CO 3	Ability to formulate, derive, analyse and synthesize kinematics and dynamics of open ended robotic mechanisms.
CO 4	Understand and apply detailed concepts relating to various actuators, sensors, and their integration with drives and signal conditioning for robotics.
CO 5	Understanding concepts of feedback control of robotic manipulators based on modern control theory;PID Control; and applying them to Joint control and trajectory control.

Detailed Syllabus

Introduction to Robotics:

Kinematics and Dynamics of Robotic linkages (open ended type manipulators):

Frames, Transformations: Translation and rotation, Denavit-Hartenberg parameters, Forward and Inverse Kinematics, Jacobian, Dynamics: Equations of motion, Newton-Euler formulation.

Sensors and actuators:

Strain gauge, resistive potentiometers, Tactile and force sensors, tachometers, LVDT, Piezo electric accelerometer, Hall effect sensors, Optical Encoders, Pneumatic and Hydraulic actuators, servo valves, DC motor, stepper motor, drives.

Control of Manipulators:

Feedback control of II order Linear systems, Joint control, Trajectory control, Controllers, PID control.

Books Recommended

1. John J. Craig, *Introduction to Robotics: Mechanics and Control*, Addison-Wesley, 2005.

2. Tsuneo Yoshikawa, *Foundations of Robotics*, MIT Press, 1990.
3. Saeed B. Niku, *Introduction to Robotics: Analysis, Systems, Applications*, Pearson Education Inc., 2001
4. Spong M. W., and Vidyasagar M., *Robot Dynamics and Control*, John Wiley & Sons, 1989.
5. Murray R. M., et al, *A Mathematical Introduction to Robotic Manipulation*, CRC Press, 1994.
6. Waldron K. J., and Kinzel G. L., *Kinematics, Dynamics and Design of Machinery*, John Wiley & Sons, 2004.
7. Eronini Umez-Eronini, *System Dynamics & Control*, Brooks/ Cole Publishing Company, 1999.
8. Amalendu Mukherjee, Ranjit Karmakar and Arun Kumar Samantaray, *Bond Graph in Modeling, Simulation and Fault Identification*, I. K. International Publishing House Pvt. Ltd, 2006.

MEOE-459	Solar Thermal Process	Department Elective	L	T	P	Credit
			3	0	0	3

Pre-requisites: None
Course Assessment Method: Both continuous and semester end examination.
Topics to be covered: All.
Course Outcomes: At the end of the course the student will be able to:

CO 1	Study of the Solar radiation on the earth surface and its characteristics, instruments used to measure solar radiation, solar radiation data, solar radiation geometry.
CO 2	Analysis of Flat plate collectors, principles of energy conversion into heat, energy balance equation, collector efficiency.
CO 3	Study of Solar energy storage like scribble heat storage, latent heat storage, thermo chemical heat storage.
CO 4	Understanding and designing Solar water heating system, pressurized and non pressurized, space heating and cooling.

Detailed Syllabus

Solar Radiation: Solar radiation outside the earth's atmosphere, solar radiation at the earth's surface, instruments for measuring solar radiation and sunshine, solar radiation data, solar radiation geometry, solar radiation on tilted surfaces.

Solar Energy Collection: Flat – Plate collectors: Transmissivity of cover system, physical principles of conversion of solar radiation into heat, energy balance equation and collector efficiency, concentrating collectors: Focusing type, selective absorber coating.

Thermal Energy Storage: Scribble heat storage, latest heat storage, thermo-chemical heat storage.

Solar Water Heating Systems: Natural circulation water heater; (pressurized and non-pressurized) Forced circulation solar water heater, space heating and cooling.

Solar Crop Drying: Working principle: Open sun drying, direct solar drying, and indirect solar drying.

Solar Distillation and Solar Pond and other Applications: Worming Principle, principle and description of solar pond and operational problem, collection – cum storage water heater, Green house, solar cooker, heating of biogas plant by solar energy.

Books Recommended

1. Sukhatme S P, "*Solar Energy: Principles of Thermal Collection and Storage"*, 2nd edition, Tata McGraw Hill, Delhi (1997).
2. Tiwari G N, *"Solar Energy: Fundamentals, Design, Modeling and Applications"*, 1st Edition, Narosa Publishing House, New Delhi (2003).
3. Rai G D, *"Non-Conventional Sources of Energy"*, 4th Edition, Khanna Publisher, Delhi (1999).
4. Agarwal M P, *"Solar Energy"* S Chand & Sons, New Delhi (1989).
5. Garg H P and Parkash J, *"Solar Energy: Fundamentals and Applications"*, Tata McGraw Hill, Delhi (2003).