SCHEME AND DETAILED

SYLLABUS

(I^{ST} TO 8^{TH} SEMESTER)

DEPARTMENT
OF
MECHANICAL ENGINEERING

B.Tech

(2019)

SAI SCHOOL OF ENGINEERING

AND

TECHNOLOGY

CURRICULUM

FOR

BACHELOR OF TECHNOLGY

IN

MECHANICAL ENGINEERING

SRI SAI UNIVERSITY, PALAMPUR

2019

General Course Structure & Theme

Course code and definition

BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
MC	Mandatory courses
BSC	Basic Science Courses

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week 2 Hours Practical(Lab)/week	0.5 credits 1 credit

B. Range of credits-A range of credits from 160 to 170 for a student to be eligible to get Under Graduate degree in Engineering.

C. Structure of Undergraduate Engineering program:

S. No.	Category	Breakup of Credits
1	Humanities and Social Sciences including Management courses	03
2	Basic Science courses	19
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	24.5
4	Professional core courses	92
5	Professional Elective courses relevant to chosen specialization/branch	11
6	Open subjects – Electives from other technical and /or emerging subjects	08
7	Project work, seminar and internship in industry or elsewhere	11
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
	Total	168.5

Study Scheme

B.Tech Mechanical Engineering 1st Semester

S. No.	Course Type	Course Code	Course Title	Load allocations			Marks distribution		Total Marks	Credits
				L	T	P	Internal	External		
1	BSC	PH-101B	Physics –I (Introduction to Mechanics)	3	1	0	40	60	100	4
2	BSC	AMME-101	Mathematics–I (Calculus & Linear Algebra)	3	1	0	40	60	100	4
3	ESC	BEE-101	Basic Electrical Engineering	3	1	0	40	60	100	4
4	ESC	ME-101P	Engineering Graphics & Design	1	0	4	60	40	100	3
5	BSC	PH-101B(P)	Physics –I Lab (Introduction to Mechanics)	0	0	3	30	20	50	1.5
6	ESC	BEE-101P	Basic Electrical Engineering Lab	0	0	2	30	20	50	1
		TOTAL		**10**	**3**	**9**	**240**	**260**	**500**	**17.5**

Study Scheme

B.Tech Mechanical Engineering 2nd Semester

S. No.	Course Type	Course Code	Course Title	Load allocations			Marks distribution		Total Marks	Credits
				L	T	P	Internal	External		
1	BSC	CH-201	Chemistry-I	3	1	0	40	60	100	4
2	BSC	AMME-201	Mathematics –II (ODE& Complex Variables)	3	1	0	40	60	100	4
3	HSMC	HSMC-201	English	2	0	0	40	60	100	2
4	ESC	CSE-201	Programming for Problem Solving	3	0	0	40	60	100	3
5	ESC	CSE-201(P)	Programming for Problem Solving Lab	0	0	4	30	20	50	2
6	ESC	ME-201(P)	Workshop/Manufacturing Practices	1	0	4	60	40	100	3
7	BSC	CH-201P	Chemistry-I Lab	0	0	3	30	20	50	1.5
8	HSMC	HSMC-201P	English Lab	0	0	2	30	20	50	1
9	MC	EVS-201	Environmental Science	3	0	0	Satisfactory / Un-Satisfactory			NC
		TOTAL		**15**	**2**	**13**	**310**	**340**	**650**	**20.5**

Study Scheme

B.Tech Mechanical Engineering 3rd Semester

S. No.	Course Type	Course Code	Course Title	Load allocations			Marks distribution		Total Marks	Credits
				L	T	P	Internal	External		
1	PCC	ME-301	Fluid Mechanics	3	1	0	40	60	100	4
2	PCC	ME-302	Theory of Machines -I	3	1	0	40	60	100	4
3	PCC	ME-303	Machine Drawing	1	0	4	60	40	100	3
4	ESC	EC-301	Basic Electronics Engineering	3	0	0	40	60	100	3
5	PCC	ME-304	Strength of Materials-I	3	1	0	40	60	100	4
6	PCC	ME-305	Applied Thermo-dynamics-I	3	1	0	40	60	100	4
7	PCC	ME-301P	Fluid Mechanics Lab	0	0	2	30	20	50	1
8	PCC	ME-302P	Theory of Machines –I Lab	0	0	2	30	20	50	1
9	PCC	ME-304P	Strength of Materials-I Lab	0	0	2	30	20	50	1
10	MC	MPD-301	Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			NC
		TOTAL		**16**	**4**	**12**	**350**	**400**	**750**	**25**

Study Scheme

B.Tech Mechanical Engineering 4th Semester

S. No.	Course Type	Course Code	Course Title	Load allocations			Marks distribution			Credits
				L	T	P	Internal	External	Total	
1	PCC	ME-401	Applied Thermo-dynamics-II	3	1	0	40	60	100	4
2	PCC	ME-402	Fluid Machines	3	1	0	40	60	100	4
3	PCC	ME-403	Strength of Materials-II	3	1	0	40	60	100	4
4	ESC	ME-404	Materials Engineering	3	0	0	40	60	100	3
5	PCC	ME-405	Theory of Machines-II	3	1	0	40	60	100	4
6	PCC	ME-401P	Applied Thermo-dynamics-II Lab	0	0	2	30	20	50	1
7	PCC	ME-402P	Fluid Machines Lab	0	0	2	30	20	50	1
8	ESC	ME-404P	Materials Engineering Lab	0	0	2	30	20	50	1
9	MC	MPD401	Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			NC
		TOTAL		**15**	**4**	**8**	**290**	**360**	**650**	**22**

Study Scheme

B.Tech Mechanical Engineering 5th Semester

S. No.	Course Type	Course Code	Course Title	Load allocations			Marks distribution		Total Marks	Credits
				L	T	P	Internal	External		
1	PCC	ME501	Heat Transfer	4	1	0	40	60	100	5
2	PCC	ME502	Design of Machine Elements	4	1	0	40	60	100	5
3	PCC	ME503	Manufacturing Processes	4	0	0	40	60	100	4
4	MC	ME504	Management and Engineering Economics	3	0	0	40	60	100	3
5	PCC	ME501P	Heat Transfer Lab	0	0	2	30	20	50	1
6	PCC	ME503P	Manufacturing Processes Lab	0	0	2	30	20	50	1
7	ESC	ME505P	Numerical Methods Lab	0	0	3	30	20	50	1.5
8	MC	MC102	Essence of Indian Knowledge tradition	3	0	0	100	00	100	NC
9		ME406	4-Weeks Industrial Training*	0	0	6	60	40	100	NC
		TOTAL		**18**	**2**	**13**	**410**	**340**	**750**	**20.5**

*The Grade of Satisfactory/Unsatisfactory of Industrial/Institutional Training imparted at the end of 4th semester will be included here.

Study Scheme

B.Tech Mechanical Engineering 6th Semester

S. No.	Course type	Course code	Course title	Load allocations			Marks distribution		Total marks	Credits
				L	T	P	Internal	External		
1	PCC	ME601	Refrigeration and Air conditioning	3	1	0	40	60	100	4
2	PCC	ME602	Mechanical Measurements and Metrology	4	0	0	40	60	100	4
3	PCC	ME603	Automobile Engineering	4	0	0	40	60	100	4
4	PCC	ME604	Introduction to Industrial Management	3	1	0	40	60	100	4
5	PE		Elective-I	3	0	0	40	60	100	3
6	MC	MC601	Constitution of India	3	0	0	50	---	50	NC
7	PCC	ME601P	Refrigeration and Air conditioning Lab	0	0	2	30	20	50	1
8	PCC	ME602P	Mechanical Measurements and Metrology Lab	0	0	2	30	20	50	1
9	PCC	ME603P	Automobile Engineering Lab	0	0	2	30	20	50	1
10		ME605	Minor Project	0	0	2	30	20	50	1
		Total		**20**	**2**	**8**	**370**	**380**	**750**	**23**

The project work will be carried out in parts as minor project in 6th semester and major project in 7th semester. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology for the project shall be decided in 6th semester. The same project problem is to be extended in the major project in semester. The minor project may be carried out by a group of students 2 to 5.

List of Elective-I :

Sr. No.	Course title	Course Code
1.	Computer Aided Design	ME606
2.	Manufacturing Technology	ME607
3.	Non- Conventional Energy Resources	ME608

Study Scheme

B.Tech Mechanical Engineering 7th Semester

S. No.	Course type	Course code	Course title	Load allocations			Marks distribution		Total marks	Credits
				L	T	P	Internal	External		
1	PCC	ME701	Automation in Manufacturing	4	0	0	40	60	100	4
2	PCC	ME702	Power Plant Engineering	3	1	0	40	60	100	4
3	PE		Elective-II	4	0	0	40	60	100	4
4	OEC		Open Elective - I	4	0	0	40	60	100	4
5	PCC	ME701P	Automation in Manufacturing Laboratory	0	0	2	30	20	50	1
6		ME707	Major Project	0	0	10	80	20	100	5
		Total		**15**	**1**	**12**	**270**	**280**	**550**	**22**

List of Elective-II:

Sr. No.	Course title	Course code
1.	Composite Materials	ME703
2.	Gas Dynamics and Jet Propulsion	ME704

List of Open Elective-I:

Sr. No.	Course title	Course code
1.	Operation Research	ME705
2.	Maintenance and Reliability	ME706

Study Scheme

B.Tech Mechanical Engineering 8th Semester

S. No.	Course type	Course code	Course title	Load allocations			Marks distribution		Total marks	Credits
				L	T	P	Internal	External		
1	PCC	ME801	Instrumentation and Control	4	0	0	40	60	100	4
2	PCC	ME802	Mechanical Vibration	3	1	0	40	60	100	4
3	PE		Elective-III	4	0	0	40	60	100	4
4	OEC		Open Elective - II	4	0	0	40	60	100	4
5		ME807	Six Week Internship*	0	0	10	50	100	150	5
	Total			**15**	**1**	**10**	**210**	**340**	**550**	**21**

* This course is aimed to provide more weightage for practical work. This internship is to be done at the end of 7th semester.

List of Elective-III

Sr. No.	Course title	Course code
1.	Mechatronic systems	ME803
2.	Finite Element Analysis	ME804

List of Open Elective-II

Sr. No.	Course title	Course code
1.	Fundamentals of Management for Engineers	ME805
2.	Product design and development	ME806

1ST SEMESTER

L	T	P
3	1	0

PH-101B: Physics-I (Introduction to Mechanics)

Course Objectives	• Learn the knowledge of vector mechanics • Know about harmonic oscillators. • Know about the three-dimensional rigid body motion • Introduce the knowledge mechanics of solids so that they can use these in Engineering as per their requirement.
Course Outcomes	• Able to understand the vector mechanics for a classical system. • Identify various types of forces in nature, frames of references, and conservation laws. • Know the simple harmonic, damped, and forced simple harmonic oscillator for a mechanical system.

Detailed Content

Module 1: Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates

Module 2: Potential energy function; F = - Grad V, equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical, parabolic and hyperbolic orbits; Kepler problem; Application: Satellite manoeuvres

Module 3: Non-inertial frames of reference; Rotating coordinate system: Five-term acceleration formula. Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum. Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance.

Module 4: Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

Module 5: Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed — only need to show that this motion looks two-dimensional but is three-dimensional, and two-dimensional formulation fails.

Text Books:

(i) Engineering Mechanics, 2nd ed. — MK Harbola
(ii) Introduction to Mechanics — MK Verma

Reference Books :

(i) Engineering Mechanics - Dynamics, 7th ed. - JL Meriam
(ii) Mechanical Vibrations — JP Den Hartog

L	T	P
3	1	0

AMME-101: Mathematics-I (Calculus & Linear Algebra)

Course Objectives	• The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. • It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.
Course Outcomes	At the end of the course, the student will be able to • To apply differential and integral calculus to notions of curvature and to improper integrals. • The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems. • The tool of power series and Fourier series for learning advanced Engineering Mathematics. • To deal with functions of several variables that are essential in most branches of engineering.

Detailed Contents

Module 1: Calculus: Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2: Calculus: Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 3: Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 4: Multivariable Calculus (Differentiation): Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Module 5: Matrices: Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Text Books:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010

L	T	P
3	1	0

BEE-101: Basic Electrical Engineering

Course Objectives	• Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context. • Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices. • To explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
Course Outcomes	At the end of the course, the student will be able to • To understand and analyze basic electric and magnetic circuits. • To study the working principles of electrical machines. • Identify the type of electrical machine used for that particular application.

Detailed Contents

Module 1 : DC Circuits (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current andvoltage laws, analysis of simple circuits with dc excitation.Superposition, TheveninandNortonTheorems.Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, realpower, reactive power, apparent power, power factor. Analysis of single-phase ac circuitsconsisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance.Threephase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Magnetic fields and magnetic circuits (6 hours)

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and BiotSavart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.BH characteristics.

Module4: Transformers & Electrical Machines (13 hours)

Transformers: Ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Electrical Machines: Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Electrical Installations (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types ofWires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Text Books

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.

Reference Books

1. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press,2011.
2. AbhijitChakrabarti, SudiptaNatha&Chandan Kumar Chand, "Basic Electrical Engineering"Tata McGraw Hill, 2009.

L	T	P
1	0	4

ME101P: Engineering Graphics & Design (Theory & Lab.)

Course Objectives	Introduction to engineering design and its place in society • Exposure to the visual aspects of engineering design • Exposure to engineering graphics standards • Exposure to solid modeling and computer-aided geometric design • Exposure to creating working drawings
Course Outcomes	• To prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability • To prepare you to communicate effectively • To prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

Detailed Contents

Module 1: Introduction to Engineering Drawing &Orthographic Projections

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module 2: Projections of Regular Solids ,Sections and Sectional Views of Right Angular Solids

Those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.
Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

Module 3: Isometric Projections, Overview of Computer Graphics

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions; listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where

applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids

Module 4: Customization & CAD Drawing,Annotations, layering & other functions

consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Applying dimensions to objects, applying annotations to drawings; Setting up and use of layers,layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models.Part editing and two-dimensional documentation of models.Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module 5: Demonstration of a simple team design project that illustrates

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerance; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text Books:

(i) Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
(ii) Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

Reference Books:

(i) Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
(ii) Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

(Corresponding set of) CAD Software Theory and User Manuals Course Outcomes

L	T	P
0	0	3

PH-101B (P): Physics-I Lab (Introduction to Mechanics)

Course Objectives	• To make the students to understand experimental physics • To apply the theoretical knowledge for developing new devices • To introduceformal structure of Mechanics of solids
Course Outcomes	• Able to associate practical knowledge with the theoretical studies. • Develop good experimental skills, including proper setup, care of equipment, conducting experiments and analyzing results in order to observe physical phenomena. • Able to document a technical report which communicates scientific information in a clear and concise manner. • Able to understand the principles of error analysis and develop skills in experimental design.

Detailed Content

List of Practical's:

1. To determine the vertical distance between two point by using sextant.
2. To determine the moment of inertia by using fly wheel.
3. To determine the diameter of sphere by using vernier caliper.
4. To determine the value of g by using Kater's pendulum.
5. To determine V-I characteristics of Photocell.
6. To determine the V-I characteristics of Zener diode.
7. To determine the refractive index of the material of the prism by using spectrometer.

Text Books:

1. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

Reference books:

1. Engineering Practical Physics, S. Panigrahi& B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
2. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
3. Practical Physics, C L Arora, S. Chand & Company Ltd.

L	T	P
0	0	2

BEE-101(P): BASIC ELECTRICAL ENGINEERING LAB

Course Objectives	• To apply the theoretical knowledge for developing new devices • To introduce measuring instruments • Study and verification of the various theorem
Course Outcomes	• Able to associate practical knowledge with the theoretical studies. • Develop good experimental skills, including proper setup, care of equipment, conducting experiments and analyzing results in order to observe physical phenomena. • Able to document a technical report which communicates scientific information in a clear and concise manner.

LABORATORY EXPERIMENTS:

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storageoscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
3. Verification of Kirchhoff's Current Law.
4. Verification of Kirchhoff's Voltage Law.
5. Study and verification of the Norton's theorem.
6. Study and verification of the Superposition theorem.
7. Study and verification of the Thevnin's theorem.
8. Study of the polarity test on single phase transformer.
9. Study of transformation ratio and turns ratio of single phase transformer.
10. Study of single phase induction motor.
11. .Study of running and reversing of single phase induction motor.
12. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (fieldwinging - slip ring arrangement) and single-phase induction machine.

Note: Students are expected to perform about 10 experiments from the following list.

Text Books

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.

Reference Books

1. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press,2011.
2. AbhijitChakrabarti, SudiptaNatha&Chandan Kumar Chand, "Basic Electrical Engineering"Tata McGraw Hill, 2009.

2ND SEMESTER

L	T	P
3	1	0

CH-201: Chemistry-I

Course Objectives	• This syllabus aims at bridging the concepts and theory of chemistry with examples from fields of practical application, thus reinforcing the connection between science and engineering. • It deals with the basic principles of various branches of chemistry which are fundamental tools necessary for an accomplished engineer.
Course Outcomes	On completion of the course, the student will be able to: The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. The course will enable the student to: • Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces. • Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques. •Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity. • List major chemical reactions that are used in the synthesis of molecules

Detailed Contents

Module 1: Atomic and molecular structure (12 lectures)

Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations.Molecular orbitals of diatomic molecules and plots of the multicenter orbitals.Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity.Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties.Band structure of solids and the role of doping on band structures.

Module 2: Spectroscopic techniques and applications (8 lectures)

Principles of spectroscopy and selection rules.Electronic spectroscopy.Fluorescence and its applications in medicine.Vibrational and rotational spectroscopy of diatomic molecules.Applications.Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques.Diffraction and scattering.

Intermolecular forces and potential energy surfaces (4 lectures)

Ionic, dipolar and van Der Waals interactions.Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module 3: Use of free energy in chemical equilibria (6 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies.Free energy and emf.Cell potentials, the Nernst equation and applications.Acid base, oxidation reduction and solubility equilibria.Water chemistry.Corrosion.

Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 4: Periodic properties (4 Lectures)

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

Module 5: Stereochemistry (4 lectures)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Organic reactions and synthesis of a drug molecule (4 lectures)

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings.Synthesis of a commonly used drug molecule.

Text Books:

(i) University chemistry, by B. H. Mahan
(ii) Chemistry: Principles and Applications, by M. J. Sienko and R.A. Plane
(iii) Fundamentals of Molecular Spectroscopy, by C. N. Banwell

Reference Books:

(i) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
(ii) Physical Chemistry, by P. W. Atkins, Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition

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AMME-201: Mathematics –II (ODE and Complex Variables)

Course Objectives	The objective of this course is to familiarize the prospective engineers with techniques in calculus, Ordinary differential equations and Complex analysis. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.
Course Outcomes	• The mathematical tools needed in evaluating multiple integrals and their usage. • The effective mathematical tools for the solutions of differential equations that model physical processes. • The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems

Detailed Contents

Module 1: Multivariable Calculus (Integration): (10 lectures)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Module 2: First order ordinary differential equations: (6 lectures)

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders: (8 lectures)

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module 4: Complex Variable–Differentiation: (8 lectures)

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable–Integration: (8 lectures)

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Text Books:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
3. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

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HSMC-201: English

Course Objectives	The objective of the course is to help the students become the independent users of English language. • Students will acquire basic proficiency in reading & listening, comprehension, writing and speaking skills. • Students will be able to understand spoken and written English language, particularly the language of their chosen technical field. • They will be able to converse fluently.
Course Outcomes	• Use English Language effectively in spoken and written forms • Comprehend the given texts and respond appropriately. • Communicate confidently in various contexts and different cultures. • Acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Detailed contents

Module 1 Vocabulary Building & Basic Writing Skills

- The concept of Word Formation
- Root words from foreign languages and their use in English
- Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
- Synonyms, antonyms, and standard abbreviations.
- Sentence Structures
- Use of phrases and clauses in sentences
- Importance of proper punctuation
- Creating coherence
- Organizing principles of paragraphs in documents
- Techniques for writing precisely

Module -2 Identifying Common Errors in Writing

- Subject-verb agreement
- Noun-pronoun agreement
- Misplaced modifiers
- Articles

- Prepositions
- Redundancies
- Clichés

Module -3 Mechanics of Writing

- Writing introduction and conclusion
- Describing
- Defining
- Classifying
- Providing examples or evidence

Module -4 Writing Practices

- Comprehension
- Précis Writing
- Essay Writing
- Business Writing-Business letters, Business Emails, Report Writing, Resume/CV

Text Books:

(i) *Practical English Usage*. Michael Swan. OUP. 1995.

(ii) *Remedial English Grammar*. F.T. Wood. Macmillan.2007

(iii) *On Writing Well*. William Zinsser. Harper Resource Book. 2001

Reference Books:

(i) *Study Writing*. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

(ii) *Communication Skills*. Sanjay Kumar and PushpLata. Oxford University Press.2011.

(iii) *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford UniversityPress

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CSE- 201: Programming For Problem Solving

Course Objectives	• To learn the fundamentals of computers. • To understand the various steps in program development. • To learn the usage of structured programming approach in solving problems. • To impart basic knowledge about simple algorithms for arithmetic and logical *problems.*
Course Outcomes	The student will learn • To write algorithms and to draw flowcharts for solving problems. • To convert the algorithms/flowcharts to C programs. • To code and test a given logic in C programming language. • To use arrays, pointers, strings and structures to write C programs. • Searching and Sorting problems.

Detailed contents

Module 1
Introduction to Programming **(4 lectures)**
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) –
(1 lecture).

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. **(1 lecture)**

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code- **(2 lectures)**

Module *2*
Arithmetic expressions and precedence **(2 lectures)**
Conditional Branching and Loops **(6 lectures)**
Writing and evaluation of conditionals and consequent branching **(3 lectures)**
Iteration and loops **(3 lectures)**
Arrays **(6 lectures)**
Arrays (1-D, 2-D), Character arrays and Strings

Module *3*
Basic Algorithms **(6 lectures)**
Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Function **(5 lectures)**
Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Module 4
Recursion **(4 -5 lectures)**
Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.
Structure **(4 lectures)**
Structures, Defining structures and Array of Structures

Module *5*
Pointers **(2 lectures)**
Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)
File handling (only if time is available, otherwise should be done as part of the lab)

Text Books:

(i) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
(ii) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Reference Books:

(i) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

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CSE- 201(P): Programming For Problem Solving Lab

Course Objectives	• Understand the basic concept of C Programming, Arrays, Strings, Functions, Pointers,and Structures. • Acquire knowledge about the basic concept of writing a program. • Role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language. • Use of conditional expressions and looping statements to solve problems associated with conditions and repetitions. • Role of Functions , recursion.
Course Outcomes	• Acquire knowledge about the basic concept of writing a program. • Understand the Role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language. • Learn how to use of conditional expressions and looping statements to solve problems associated with conditions and repetitions. • Understand the Role of Functions involving the idea of modularity. • Understand the Concept of Array and pointers dealing with memory management. • Learn Structures and unions through which derived data types can be formed.

Detailed contents

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation,numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling:
Lab 12: File operations

TextBooks:

(iii) Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
(iv) E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Reference Books:

(ii) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

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ME201P: Workshop / Manufacturing Practices

Course Objectives	• To expose the students to the principles of different manufacturing techniques and learn advanced operations of machining. • To understand Procedure or methodologies for conducting the casting and welding processes. • To understand working of various machine tools. • To understand innovative conceptual idea about latest manufacturing processes and their industrial applications.
Course Outcomes	On completion of this course, students will be • Able to apply knowledge of manufacturing processes and the skills to develop and manipulate the operating parameters for a given process. • Able to understand processing of plastic and ceramic materials. • Ability to understand the latest technologies in casting and welding processes will get increased.

Detailed Contents

(i) Theory

Module 1: Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lectures)
Module 2: Fitting operations & power tools (2 lecture)
Module 3: Carpentry (1 lecture)
Module 4: Metal casting (2 lecture)
Module 5: Welding (arc welding & gas welding), brazing (2 lecture)

(ii) Workshop Practice:

1. Machine shop (12 hours)
2. Fitting and Sheet metal shop (8 hours)
3. Carpentry shop (6 hours)
4. Welding shop (10 hours (Arc welding 5 hrs + gas welding 5 hrs)
5. Foundary shop (6 hours)
6. Smithy shop (4 hours)

Text Books:

(i) Rao P.N., " Manufacturing Technology" , Vol. I and Vol. II, Tata McGrawHill House, 2017.
(ii) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., " Elements of Workshop Technology" , Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

Reference Books:

(i) Kalpakjian S. And Steven S. Schmid, " Manufacturing Engineering and Technology" , 4th edition, Pearson Education India Edition, 2002.
(ii) Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

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CH-201P: Chemistry-I Lab

Course Objectives	The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to: • Estimate rate constants of reactions from concentration of reactants/products as a function of time • Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc • Synthesize a small drug molecule and analyse a salt sample
Course Outcomes	• To expose the students for practical training through experiments to understand and appreciate the concepts learnt in Chemistry. • The student is expected to learn from this laboratory course the concept of error and its analysis. • It also allows the student to develop experimental skills to design new experiments in Engineering.

Detailed Contents

Choice of 10-12 experiments from the following

1. Determination of surface tension and viscosity
2. Thin Layer Chromatography
3. Ion exchange column for removal of hardness of water
4. Colligative properties using freezing point depression
5. Determination of the rate constant of a reaction
6. Determination of cell constant and conductance of solutions
7. Potentiometry-determination of redox potentials and emf
8. Synthesis of a polymer/drug
9. Saponification/acid value of an oil
10. Chemical analysis of a salt
11. Lattice structures and packing of spheres
12. Models of potential energy surfaces
13. Chemical oscillations- Iodine clock reaction
14. Determination of the partition coefficient of a substance between two immiscible liquids
15. Adsorption of acetic acid by charcoal
16. Use of the capillary viscometers to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Text Books:

(i) University chemistry, by B. H. Mahan
(ii) Fundamentals of Molecular Spectroscopy, by C. N. Banwell

Reference Books:

(i) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

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HSMC-201P: English Lab

Course Objectives:	• To learn better English pronunciation • To use language effectively in everyday conversations • To make formal oral presentations using effective strategies in professional life • To be exposed to a variety of self-instructional, learner friendly modes of language learning
Course Outcomes:	• The objective of the course is to help the students become the independent users of English language. • Students will acquire basic proficiency in listening and speaking skills. • Students will be able to understand spoken English language, particularly the language of their chosen technical field. • They will be able to converse fluently • They will be able to produce on their own clear and coherent texts

Detailed Contents

Interactive practice sessions in Language Lab on Oral Communication

- Listening Comprehension
- Self-Introduction, Group Discussion and Role Play
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Text Books:

(i) *Practical English Usage*. Michael Swan. OUP. 1995.

(ii) *Communication Skills*. Sanjay Kumar and PushpLata. Oxford UniversityPress. 2011.

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EVS-201 : Environmental Science

Course Objectives:	• To learn different natural resources including renewable resources. • To Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
Course Outcomes:	• Develop an understanding of Develop an understanding of environmental pollutions and hazards due to engineering/technological activities and general measures to control them. • Demonstrate an appreciation for need for sustainable development and role of science. \ • Aware of important acts and laws in respect of environment

Detailed Contents

Module 1: The Multidisciplinary nature of environmental studies
Definition, scope and importance, Need for public awareness. Natural Resources Renewable and non renewable resources: Natural resources and associated problems

Module 2:
• Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people.
• Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.
• Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
• Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, case studies.
• Energy Resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies
Land Resources: Land as a resource, land degradation, man induces land slides, soil erosion, and desertification.
Role of individual in conservation of natural resources.
Equitable use of resources for sustainable life styles.

Module 3: Eco Systems
Concept of an eco system, Structure and function of an eco system. , Producers, consumers, decomposers.
Energy flow in the eco systems. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following eco systems Forest ecosystem Grass land ecosystem Desert ecosystem. Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

Module 4 : Biodiversity and it's Conservation

Introduction-Definition: genetics, species and ecosystem diversity. India as a mega diversity nation, threat to biodiversity: habitats loss, endangered and endemic spaces of India
Conservation of biodiversity
Environmental Pollution
Definition Causes, effects and control measures of Air pollution, Water pollution soil pollution, Noise pollution and Nuclear Hazards

Solid waste Management: Causes, effects and control measures

Module 5 :

Social issues and the environment: Urban problems related to energy, water conservation, rain water harvesting
Climate change, global warming, Environment protection act
Human population and the environment: population growth, Human rights, Women and child welfare

Text Books:

1. Textbook of Environment studies, Erach Bharucha, UGC
2. Fundamental concepts in Environment studies, DD Mishra, S Chand & Co Ltd

3RD SEMESTER

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ME-301: Fluid Mechanics

Course Objectives	• To introduce and explain fundamentals of Fluid Mechanics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc. . • To inculcate the importance of fluid flow measurement and its applications in Industries. • To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.
Course Outcomes	After studying this course, students will be able to: • Understand the concept of fluids and their properties. • Apply the concept to solve the problems related to statics, dynamics and kinematics of fluids. • Use and apply dimensional analysis and similitude techniques to various physical fluid phenomena. • Distinguish various types of flows and learn flow measurement methods.

Detailed Contents

Module 1: Fundamentals of Fluid Mechanics: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids. **02 Hrs**

Module 2: Fluid Statics: Concept of static fluid pressure; Pascal's law and its engineeringapplications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subject to: (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) constant rotation. **06 Hrs**

Module 3: Fluid Kinematics: Classification of fluid flows; Lagrangian and Euler flow descriptions;Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them; Flow net.**07 Hrs**

Module 4: Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, andalong a streamline; Derivation of Bernoulli's equation using principle of conservation of energy and equation of motionand its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions. **07 Hrs**

Dimensional Analysis and Similitude: Need of dimensional analysis; Fundamental andderived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froude, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws. **04 Hrs**

Module 5: Internal Flows: Laminar and Turbulent Flows: Reynolds number, critical velocity, criticalReynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart. **06 Hrs**
Pressure and Flow Measurement: Manometers; Pitot tubes; Various hydrauliccoefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters. **04 Hrs**

Text Books:

1. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", S.K. Kataria and Sons Publishers, 1st Edition, 2009.
2. Y.A. Cengel and J.M. Cimbala, "Fluid Mechanics - Fundamentals and Applications", Tata McGraw Hill Publications, 3rd Edition, 2013.

Reference Books:

1. S.K. Som, G. Biswas and S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill Publications, 3rd edition, 2011.
2. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, "Fluid Mechanics and Machinery", Oxford University Press,1st Edition, 2010.

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ME-302: Theory of Machines –I

Course Objectives	• To develop competency in understanding of theory of all types of gears. • To understand the analysis of gear train. • To develop competency in drawing the cam profile. • To make the student conversant with synthesis of the mechanism. • To understand step-less regulations. • To understand mechanisms for system control – Gyroscope.
Course Outcomes	*After studying this course, students will be able to:* • Understand constructional and working features of important machine elements. • Design belt, rope and chain drives for transmission of motion from one shaft to another. • Identify different Cam and follower pairs for different applications and construct cam profile for required follower motion. • Understand the function of brakes, dynamometers, flywheel and governors

Detailed Contents

Module 1: Basic Concept of machines: Link, Mechanism, Kinematic Pair and Kinematic Chain,Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity,
and Acceleration of mechanisms including Corliolis Components. **06 Hrs**

Module 2: Lower and higher Pairs: Universal Joint, Calculation of maximum Torque, SteeringMechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs with examples. **05 Hrs**

Module 3: Belts, Ropes and Chains: Material & Types of belt, Flat and V-belts, Rope & ChainDrives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and itseffect on power transmission. **05 Hrs**

Module 4: Cams: Types of cams and follower, definitions of terms connected with cams.Displacement,velocity and acceleration diagrams for cam followers. Analytical and Graphical design of camprofiles with various motions (SHM, uniform velocity, uniform

acceleration and retardation,cycloidal Motion). Analysis of follower motion for circular, convex and tangent cam profiles. **05 Hrs**

Friction Devices: Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption, and transmission). **06 Hrs**

Module 5: Flywheels: Turning moment and crank effort diagrams for reciprocating machines'Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimentions of flywheel used for engines and punching machines. **03 Hrs**

Governors: Function, types and characteristics of governors. Watt, Porter and Proellgovernors.Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction. **06 Hrs**

Text Books:

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi.
2. V.P. Singh, Theory of Machines, Dhanpat Rai.

Reference Books:

1. Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co.
2. Thomas Beven, Theory of Machines, Longman's Green & Co., London.
3. W. G. Green, Theory of Machines, Blackie & Sons, London

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ME-303: Machine Drawing

Course Objectives	Student will get methodically and well thought out presentation that covers fundamental issues common to almost all areas of machine drawing. • Students have an ability to apply knowledge of Modeling, science & engineering. • Student can modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing. • Students will able to demonstrate an ability to design and conduct experiments, analyze and interpret data and assembly and disassembly drawings knowledge will be provided
Course Outcomes	After studying this course; the student will be able to: • Read, draw and interpret the machine drawings and related parameters. • Use standards used in machine drawings of machine components and assemblies. • Learn the concept of limits, fits and tolerances in various mating parts. • Visualize and generate different views of a component in the assembly.

Detailed Contents

Module 1: Introduction: Classification of drawings, Principles of drawing, Requirements of machineDrawing, sectional views and conventional representation, dimensioning, concept of limits, fits & tolerances and their representation, machining symbols, various types of screw threads, types of nuts and bolts, screw fasteners, welded joints and riveted joints, introduction and
familiarization of code SP 46:2003 by Bureau of Indian Standards. **15 Hrs**

Module 2: Free hand sketches of:

a. Couplings: solid and rigid couplings, protected type flange coupling, pin type flexiblecoupling, muff coupling.
b. Knuckle and cotter joints.
c. Pipe and Pipe fittings: Flanged joints, spigot and socket joint, union joint, hydraulic and expansion joint. **15 Hrs**

Module 3: Assembly of:

a. IC Engine Parts: piston and connecting rod.
b. Boiler Mountings: Steam stop valve, blow off cock, feed check valve and springloaded safety valve.
c. Bearing: Swivel bearing, Plummer Block and Foot Step bearing.
d. Miscellaneous: Screw jack, Tail Stock and crane hook. **20 Hrs**

Module 4: Practice using Computer Aided Drafting (CAD) tools for:

(a) Machine components, screw fasteners, Keys cotters and joint, shaft couplings, Pipe joints and fittings, riveted joints and welded Joints.

(b) Assemblies: - Bearings (Plumber Block, Footstep, Swivel), boiler mountings, screw jack, Exercise in computer Plots of drawing

(c) Case studies in computer plots and industrial blueprint **10 Hrs**

Text Books:

1. P.S Gill, "Machine Drawing", S K Kataria and sons, 18th edition, 2017 reprint
2. N.D.Bhatt, "Machine Drawing". Charotar publications, 49th edition, 2014

Reference Books:

1. Ajeet Singh, "Machine Drawing (including Auto CAD)", Tata McGraw Hill, 2nd edition,2012
2. G. Pohit, "Machine Drawing with Auto CAD", Pearson Education Asia, 2007.
3. IS code SP 46(2003): Engineering Drawing Practice for schools and colleges by Bureau of Indian Standards.

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EC-301: Basic Electronics Engineering

Course Objectives	• This is one of the fundamental courses meant to recall concepts of semiconductor physics. • The course deals design & analytical concepts of various analog circuits like BJT/FET circuits. • To understand the functioning of OP-AMP and design OP-AMP based circuits.
Course Outcomes	After completion of the course, a student would be acquainted with the following: • Understand the principles of semiconductor Physics. • Understand working of BJT and MOSFET with their equivalent small signal models. • Understand the functioning of OP-AMP and design OP-AMP based circuits. • Design & analyze modular combinational circuits with MUX/DEMUX, Decoder, Encoder

Detailed Contents

Module 1: Semiconductor Diodes and Applications - Semiconductor Diode - Ideal versus Practical, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications;

Module 2: Transistors & Amplifiers - Bipolar Junction Transistor (BJT)–Construction, Operation, Common Base, Common Emitter and Common Collector Configurations, Distortion, Operating Point, Voltage Divider Bias Configuration; Introduction to nMOS and pMOS.

Module 3: Operational Amplifiers and Applications - Introduction to Op-Amp, BlockDiagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground, Op-Amp Applications – Adder, Subtractor, Voltage Follower and Comparator; Differentiator and Integrator, Square Wave and Triangular Wave Generation.

Module 4: Digital Electronics -Boolean Algebra - Binary, Octal, Hexadecimal NumberSystems, Addition, Subtraction using 1's and 2's compliment method, Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs); K-Map simplification Truth Tables and Functionality of Flip-Flops – SR, JK and D Flip-Flop.

Text Books:

i. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India.
ii. SantiramKal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India.

Reference Books:

i. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education.
ii. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH

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ME-304: Strength of Materials-I

Course Objectives	• To understand the nature of stresses induced in material under different loads. • To plot the variation of shear force and bending moments over the beams under different types of loads. • To understand the behavior of beams subjected to shear loads. • To understand the behavior of beams under complex loading. • To analyze the cylindrical shells under circumferential and radial loading
Course Outcomes	At the end of the course, the student will be able to • Understand the concepts of stress and strain at a point, in the members subjected to axial, bending, torsional loads and temperature changes. • Determine principal stresses, maximum shearing stress and their angles, and the stresses acting on any arbitrary plane within a structural element. • Find bending moment and shear force over the span of various beams subjected to different kinds of loads. • Calculate load carrying capacity of columns and struts and their buckling strength. • Evaluate the slope and deflection of beams subjected to loads.

Detailed Contents

Module 1: Simple, Compound Stresses and Strains: Stress and Strain and their types, Hook's law,longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress. Generalized Hook's law, principal stresses related to principal strains. **08 Hrs**

Module 2: Bending Moment (B.M) and Shear Force (S.F) Diagrams: S.F and B.M definitions;relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum B.M and S.F and the point of contra flexure under different loads: Concentrated loads, Uniformity distributed loads over the whole span or part of span, Combination of concentrated and uniformly distributed load, Uniformly varying loads and Application of moments. **06 Hrs**

Module 3: Bending Stresses in Beams: Assumptions in the simple bending theory; derivation offormula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in afore-mentioned sections, composite / flitched beams. **05 Hrs**

Module 4: Torsion: Derivation of torsion equation and its assumptions and its application to thehollow 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. **05 Hrs**

Columns and struts: Introduction, failure of columns, Euler's formula, Rankine-Gordon'sformula, Johnson's empirical formula for axially loaded columns and their applications.

05 Hrs

Module 5: Slope and deflection: Relationship between moment, slope and deflection; method ofintegration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for: Cantilevers, Simply supported beams with or without overhang, Under concentrated loads, uniformly distributed loads or combination of concentrated
&uniformly distributed loads. **07 Hrs**

Text Books:

1. S. S. Rattan, "Strength of Materials", Tata McGraw Hill, New Delhi.
2. R. K. Bansal, "A Text Book of Strength of Materials", Laxmi Publications, New Delhi.
3. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi.

Reference Books:

1. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers and Distributors, New Delhi.
2. Pytel&Kiusalaas, "Mechanics of Materials", Cengage Learning, New Delhi.
3. D. K. Singh, "Strength of Materials", Ane Books Pvt. Ltd., New Delhi

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ME-305: Applied Thermodynamics-I

Course Objectives	• This course aims to provide a good platform to mechanical engineering students to understand, model and appreciate concept of dynamics involved in thermal energy transformation. • To prepare them to carry out experimental investigation and analysis at later stages of graduation.
Course Outcomes	*After studying this course, students will be able to:* • Learn the functioning and performance evaluation of reciprocating air compressors. • Analyze the combustion phenomenon in boilers and I.C. engines. • Use of Steam Tables and MollierChart to solve vapour power cycle problems. • Explain the constructional features and working of steam power plants and to evaluate their performance.

Detailed Contents

Module 1: Reciprocating Air Compressors:-Single stage single acting reciprocating compressor(with and without clearance volume): construction, operation, work input andbest value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic and mechanical efficiency, Clearance volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; **Multistage compressors:** purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal, isentropic, polytropic and mechanical efficiencies; Performance curves. **5 Hrs**

Module 2: Thermodynamics of Combustion in Boilers and IC Engines: Principle of Combustion;Stoichio-metric and non-stoichiometeric combustion; Combusion Problems in boilers & IC Engines; Calculations of air fuel ratio: Analysis of products of combustion, conversion of volumetric analysis into gravimetric analysis and vice versa, Actual weight of air supplied, use of mols. for solution of combustion problems; Heat of formation; Enthalpy of formation; Enthalpy of reaction/combustion and it's evaluation; first law analysis of reacting system: steady flow and Closed Systems, adiabatic flame temperature and its determination. Various
stages of combustion in IC Engines. **5 Hrs**

Module 3: Steam: Properties of Steam Pure substance ; Steam and its formation at constant pressure:wet, dry, super-saturated and super-heated (*super-saturated*) steam; Sensible heat*(sensibleenthalpy),* latent heat (*latent enthalpy*) and total or stagnation heat (*total or stagnation enthalpy*) of steam; dryness fraction and its determination; degree of superheat and degree ofsub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Charts; Basic thermodynamic processes with steam(isochoric, isobaric, isothermal,

isentropic and adiabatic processes) and their representation on T-S Charts and Mollier Charts(**h-s** diagrams), significance of Mollier Charts. **5 Hrs**

Vapour Power Cycle: Carnot Cycle and its limitations; Rankine steam power cycle, Idealand actual; Mean temperature of heat addition; Effect of pressure, temperature and vacuum on Rankine Efficiency; Rankine Cycle Efficiency and methods of improving Rankine efficiency: Reheat cycle, Bleeding(feed-water-heating), Regenerative Cycle, Combined reheat-regenerative cycle; Ideal working fluid; Binary vapour cycle, Combined power and heating cycles. **5 Hrs**

Module 4: SteamNozzles: Definition, types and utility of nozzles; Flow of steam through nozzles;Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Area of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; ConvergertandConvergant-divergant nozzles. Calculation of Nozzle dimensions(length and diameters of throat and exit); Supersaturated(or metastable) flow through nozzle. **5 Hrs**

Steam Turbines(Impulse Turbine): Introduction; Classification; Impulse versus Reactionturbines. Simple impulse/**De Level** turbine: pressure and velocity variation, Compounding of impulse turbines: purpose, types and pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency overall efficiency and relative efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge. **5 Hrs**

Module 5: Reaction Turbine:- Pressure and velocity variation, velocity diagrams/triangles, Degree ofreaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; **Multistaging:** Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction Turbines ; Co-generation; Economic assessment; Governing of steam turbines. **5 Hrs**

Steam Condensers:- Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity; Cooling towers: function, types and their operation. **5 Hrs**

Text Books:

1. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
2. D.S. Kumar and V.P. Vasandani, "Heat Engineering",Metropolitan Book Co. Pvt. Ltd
3. P.K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
4. C.P. Arora, "Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel

Reference Books:

1. E.F. Obert, "Concepts of Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
2. W.A.J. Keartan, Steam Turbine: , "Theory and Practice", ELBS Series.

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ME-301P: Fluid Mechanics Lab.

Course Objectives	• This course aims to provide a good platform to mechanical engineering students to understand, model and appreciate concept of dynamics involved in the fluid mechanics. • To prepare them to carry out experimental investigation and analysis at later stages of graduation.
Course Outcomes	*After studying this course, students will be able to:* • Learn the functioning and performance evaluation of flow meters. • Analyze the Bernoulli's energy equation • Use of various types of pumps.

1 To determine the metacentric height of a floating vessel under loaded and unloaded conditions.

2 To study the flow through a variable area duct and verify Bernoulli's energy equation.

3 To determine the coefficient of discharge for an obstruction flow meter (venturi meter/ orifice meter)

4 To determine the friction coefficients, head loss in pipes.

Text Books:

1. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", S.K. Kataria and Sons Publishers, 1st Edition, 2009.
2. Y.A. Cengel and J.M. Cimbala, "Fluid Mechanics - Fundamentals and Applications", Tata McGraw Hill Publications, 3rd Edition, 2013.

Reference Books:

1. S.K. Som, G. Biswas and S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill Publications, 3rd edition, 2011.
2. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, "Fluid Mechanics and Machinery", Oxford University Press,1st Edition, 2010.

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ME-302P: Theory of Machines –I Lab.

Course Objectives	To determine the balancing of masses of rotating and reciprocating machine elements 2. To understand the principles of gyroscope and governors 3. To study working of brakes and dynamometer 4. To determine the moment of inertia of various mechanical systems 5. To understand the vibrational behavior of systems
Course Outcomes	*After studying this course, students will be able to:* 1. Ability to apply the principles of balancing of masses to various links, mechanisms and engines 2. Ability to apply the principles of gyroscopic effects and stabilization on various transport vehicles and applications of various governors 3. Ability to understand the working principles of brakes and dynamometer 4. Ability to determine moment of inertia of mechanical systems 5. Ability to determine the vibration parameters of different systems

Detailed Contents

List of experiments

1 Conduct experiments on various types of governors and draw graphs between height and equilibrium speed of a governor.
2 Determination of gyroscopic couple (graphical method).
3 Balancing of rotating masses (graphical method).
4 Cam profile analysis (graphical method)
5 Determination of gear- train value of compound gear trains and epicyclic gear trains.
2.6 To draw circumferential and axial pressure profile in a full journal bearing.

Text Books:

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi.
2. V.P. Singh, Theory of Machines, Dhanpat Rai.

Reference Books:

1. Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co.
2. Thomas Beven, Theory of Machines, Longman's Green & Co., London.
3. W. G. Green, Theory of Machines, Blackie & Sons, London

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ME-304P : Strength of Materials-I Lab.

Course Objectives	The objective of the strength of materials lab is to demonstrate the basic principles in the area of strength and mechanics of materials and structural analysis to the undergraduate students through a series of experiments. In this lab the experiments are performed to measure the properties of the materials such as impact strength, tensile strength, compressive strength, hardness, ductility etc.
Course Outcomes	*After studying this course, students will be able to:* Learn the functioning and performance evaluation of reciprocating air compressors. Analyze the combustion phenomenon in boilers and I.C. engines. Use of Steam Tables and MollierChart to solve vapour power cycle problems. Explain the constructional features and working of steam power plants and to evaluate their performance.

Detailed Contents

List of experiments

1 To perform tensile and compression test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2 To perform any hardness tests (Any one from Rockwell, Brinell &Vicker's test).
3 To perform impact test to determine impact strength.
3 To perform torsion test and to determine various mechanical properties.
4 To perform Fatigue test on circular test piece.
5 To perform bending test on beam and to determine the Young's modulus and modulus of rupture.
6 Determination of Bucking loads of long columns with different end conditions.

Text Books:

1. S. S. Rattan, "Strength of Materials", Tata McGraw Hill, New Delhi.
2. R. K. Bansal, "A Text Book of Strength of Materials", Laxmi Publications, New Delhi.
3. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi.

Reference Books:

1. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers and Distributors, New Delhi.
2. Pytel&Kiusalaas, "Mechanics of Materials", Cengage Learning, New Delhi.
3. D. K. Singh, "Strength of Materials", Ane Books Pvt. Ltd., New Delhi

4TH SEMESTER

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ME-401 Applied Thermodynamics-II

Course Objectives:	• The usage of fundamental knowledge on thermodynamic cycles and fluid dynamics phenomena present in turbomachinery and combustion for producing electric and mechanical energy/power. • II. The operational concepts, principles, features, procedures and detailed thermodynamic analyses related to components of power cycles, rocket propulsion as well as steam and power generators. • III. The designing approaches for developing governing equations and correlations related to intricate parts of turbomachinery and their components with due consideration of effect on the performance. • IV. A wealth of real world engineering problems and examples towards gaining the experience for designing and developing power generating systems in engineering practice.
Course Outcomes:	*After studying this course, students will be able to:* • Understand working and performance of IC Engines. • Demonstrate the constructional & design features, understand working principles & performance parameters and conduct thermodynamic analysis of rotary compressors. • Conduct thermal analysis of gas turbines • Conduct thermal analysis of jet propulsion and rocket propulsion systems.

Detailed Contents:

Module 1: IC Engines: Pressure-Time/Pressure-ɵdiagram, Characteristics of the fuel oil for a dieselengine; Combustion process in diesel engine, and various parameters controlling the delay Period; Uncontrolled combustion, Diesel knock or Fuel knock, period of controlled combustion, effect of turbulence on power and efficiency, after-burning etc. **Petrol Engines:** Royal Automobile club rating of Petrol Engines, causes of lower pressure rise during combustion than expected; Process of combustion in a Petrol engine, Ignition lag and factors effecting it, Rate of flame propagation and various factors effecting it, detonation(in Petrol engines) and various factors affecting it; comparison of diesel knock and detonation and effect of various parameters on these; comparison of pre-ignition and detonation; dopes/antiknock substances for SI/CI Engines; Effect of compression ratio and fuel-air ratio on power and efficiency of **(i)** Diesel Engines **(ii)** Petrol Engines. Performance curves for a petrol engine at constant speed; Consumption loops for Petrol and Diesel engines; Effect of turbulence on Petrol and Diesel engines; Dissociation and it's effect on power and efficiency; Octane and Cetane numbers, Knock-meter; Use of high speed cinmetography for observation of burning gases characteristics; various methods of Governing IC Engines; Super-charging and its methods, Advantages of super-charging; Variation of Engine power with altitude; causes of pressure loss at high altitudes and power requirements of Super-chargers; Effect of Super-charger on PV- diagrams of SI Engines; High Speed Engine Indicators: Farnborough balanced Engine Indicator; Cathode-ray Oscillograph Engine Indicator;

Construction and working principle of Rotary or Wankel Engine, it's advantages and disadvantages over reciprocating piston engines; application of Wankel Engine; Logrithmic plotting of PV-diagrams. **6 Hrs**

Module 2: Air Compressors:- Introduction, Classification of Air Compressors; Application ofcompressors and use of compressed air in industry and other places; Complete representation of compression process(for Reciprocating and Rotary compressors) on P-v and T-s coordinates with detailed description of areas representing total work done and polytropic work done; Areas representing energy lost in internal friction, energy carried away by cooling water and additional flow work being done for un-cooled and cooled compression processes on T-S coordinates; Best value of index of compression; Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-S coordinates. Applications of Steady-Flow-Energy Equation and thermodynamics of dynamic(i.e., centrifugal and axial flow machines); Stagnation and static values of pressure, Temperature and enthalpy (and their co-relation) etc. for flow through dynamic,rotary machines. **5 Hrs**

Positive Displacement Rotary Compressors:- Introduction and general classification ofrotary Comressors**;** Comparison of rotary positive displacement compressors with reciprocating compressors; **Classification** of rotary compressors: Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compressor and Vane-type Blower. **5 Hrs**

Module 3: Centrifugal Compressors:- Complete thermodynamic analysis of a centrifugalcompressor stage; Polytropic, isentropic and isothermal efficiencies; Complete representation of compression process in a centrifugal compressor starting from ambient air flow through the suction pipe, Impeller, Diffuser and finally to the delivery pipe on T-S coordinates; Pre-guide vanes and pre-whirl; Slip factor; Power input factor; Various modes of energy transfer in the impeller and diffuser; Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of Slip factor and its effect on efficiency and outcoming***velocity profile*** from the impeller; Derivation of non-dimensional parameters for plotting compressor characteristics; Centrifugal compressor characteristic curves; Surging and choking in centrifugal compressors. **5 Hrs**

Module 4: Axial Flow Compressors:- Different components of axial flow compressor and theirarrangement; Discussion on flow passages and simple theory of aerofoil blading; Angle of attack; coefficients of lift and drag; Turbine versus Compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work Done on the compressor and Power calculations; Modes of energy transfer in rotor and stator blade flow passages; Detailed discussion on Work Done factor, degree of reaction, blade efficiency and their derivations; 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 like Pressure Coefficient, Flow Coefficient, Work Coefficient, Temperature-rise Coefficient and Specific Speed; Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors. **5 Hrs**

Module 5: Gas Turbines:- Classification and comparison of the Open and Closed cycles;Classification on the basis of combustion(at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and reheating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle, Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels. **5 Hrs**

Jet Propulsion: - Principle of jet propulsion; Description of different types of jetpropulsion systems like rockets and thermal jet engines, like **(i)**Athodyds (ramjet and pulse-jet), **(ii)** Turbojet engine, and **(iii)** Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal(*internal*) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors(e.g. ***solid propellant*** and ***liquid propellant*** systems); Various common propellant combinations (i.e. of fuels) used inrocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units. **5 Hrs**

Text Books: -

1. V. Ganeshan ,"Internal Combustion Engines", Tata McGraw Hill Pvt. Ltd.,7 West Patel Nagar, New Delhi-110 008.
2. VP Vasandani and DS Kumar, "Heat Engineering"; Metropolitan Book Co. Pvt Ltd., Delhi.
3. R. Yadav, "Thermodynamics and Heat Engines, Vol-II", Central Publishing House, Allahabad.

Reference Books: -

1. Cohen H and Rogers GFC, "Gas Turbine Theory"; Longmans
2. V Kadambi, Manohar Prasad, "An Introduction to Energy Conversion", Wiley Eastern Ltd, AB and Safdarjang Enclave, New Delhi
3. D.B.Spalding and E.H. Cole,"Engineering Thermodynamic", Edward Wrnold Ltd. And E.L.B.S.(English Language Book Society)

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ME-402: Fluid Machines

Course Objectives:	This course offers basic knowledge on fuild statics, dynamics and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery
Course Outcomes:	After studying this course, students shall be able to: • Recognize basic components of turbo machines and understand related fundamental laws/ principles and apply these for calculation of various parameters like work done, force efficiency etc. • Know about constructional details, working and design aspects of runner/wheel and evaluate the performance of various turbines like Pelton, Kaplan and Francis. • Know about constructional details, working and evaluate the performance of centrifugal pump under different vane shape conditions. • Know about constructional details, working and evaluate the performance of reciprocating pump and evaluate the effect of various deviations from the ideal conditions on the work done. • Know about constructional details and working of hydraulic devices like fluid coupling, accumulator and intensifier.

Detailed Contents:

Module 1:General Concepts: Impulse momentum principle; jet impingement on stationary andmoving flat plates; and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted; work done and efficiency of jet. Basic components of a turbo machine 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 turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes. **07 Hrs**

Module 2:Pelton Turbine: Component parts and operation; velocity triangles; 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; governing of Pelton turbine. **05 Hrs**

Francis and Kaplan Turbines: Component parts and operation velocity triangles andwork 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; governing of reaction turbines. **06 Hrs**

Module 3:Centrifugal Pumps: Layout and installation; Main elements and their functions; Varioustypes and classification; Pressure changes in a pump; Heads of a pump - suction; delivery; static; manometric; total; net positive suction head and Euler's head; 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; model testing and Priming and priming devices; Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps;
Trouble shooting - field problems; causes and remedies. **06 Hrs**

Module 4: Similarity Relations and Performance Characteristics: Unit quantities; specific speed and model relationships; scale effect; Cavitation and Thomas's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application. **04 Hrs**

Reciprocating Pumps: Introduction to single acting and double acting reciprocatingpumps; their components; and 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; Functions of Air vessels. **05 Hrs**

Module 5: Hydraulic Devices and Systems: Construction; operation and utility of simple and differential accumulator; intensifier; fluid coupling and torque converter; Air lift and jet pumps; gear; vane and piston pumps; Hydraulic Ram; Hydraulic lift; Hydraulic crane and Hydraulic press. **03 Hrs**

Text Books:

1. R.L. Daughaty, Hydraulic Turbines, McGraw Hill
2. Jagdish Lal, Hydraulic Machines by Metropolitan Book Co
3. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,

Reference Books:

1. K. Subramaniam, Hydraulic Machines, Tata Mc Graw Hill
2. R.K. Purohit., Hydraulic Machines, Scientific Publishers
3. C.S.P.Ojha, R.Berndtsson, P.Chandramouli, "Fluid Mechanics and Machinery", Oxford University Press, 201

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ME-403: Strength Of Materials-II

Course Objectives:	To establish an understanding of the fundamental concepts of mechanics of deformable solids; including static equilibrium, geometry of deformation, and material constitutive behavior. To provide students with exposure to the systematic methods for solving engineering problems in solid mechanics. To discuss 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. To build the necessary theoretical background for further structural analysis and design courses.
Course Outcomes:	At the end of the course, the student will be able to: • Apply the basics to find stresses in various applications (shells, curved beams and rotating discs). • Analyse the change in dimensions of shells, curved beams and rotating discs under operation. • Determine stresses, deflection and energy stored in various kinds of springs subjected to load and twist. • Understand the concept of failure theories and strain energy. • Evaluate shearing stress variation in beams of different cross-section and materials.

Detailed Contents:

Module 1: Strain Energy: Introduction to strain energy, energy of dilation and distortion. Resilience,stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal
deflection. **05 Hrs**

Module 2 : Theories of Failure: Maximum principal stress theory, maximum shear stress theory,maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to
problems related to two-dimensional stress systems. **05 Hrs**

Module 3:
Springs: Open and closed coiled helical springs under the action of axial load and/orcouple. Flat spiral springs- derivation of formula for strain energy, maximum stress and
rotation. Leaf spring deflection and bending stresses. **05 Hrs**

Thin Cylinders and Spheres: Calculation of Hoop stress, longitudinal stress in a cylinder,effects of joints, change in diameter, length and internal volume. Principal stresses in sphere,
change in diameter and internal volume. **05 Hrs**

Module 4:

Thick Cylinders: Derivation of Lame's equations, calculation of radial, longitudinal andhoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress. **05 Hrs**

Bending of Curved Beams: Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section, and chain links with straight sides. **04 Hrs**

Module 5:

Shear Stresses in Beams: Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance. **04 Hrs**

Rotational Discs: Stresses in rotating discs and rims of uniform thickness; disc of uniform Strength. 03 Hrs

Text Books:

1. S. S. Rattan, "Strength of Materials"Tata McGraw Hill, New Delhi

2. R. K. Bansal, "A Text Book of Strength of Materials", Laxmi Publications, New Delhi
3. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi

Reference Books:

1. Kirpal Singh, "Mechanics of Materials", Standard Publishers, New Delhi.
2. R.S. Lehri, "Strength of Materials", Katson Publishers, New Delhi

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ME-404: Materials Engineering

Course Objectives:	Give basic knowledge of science behind materials & physical metallurgy. Introduce the concept of structure property relations. Lay the groundwork for studies in fields such as solid-state physics, mechanical behavior of materials, phase & phase diagram, heat treatment, failure of materials & their protection, applications of Recent materials. Develop intuitive understanding of the subject to present a wealth of real world engineering examples to give students a feel of how material science is useful in engineering practices.
Course Outcomes:	*After studying this course, students shall be able to:* • Understand the significance of structure-property-correlation for engineering materials including ferrous and nonferrous. • Explain the use and importance of various heat treatment processes used for engineering materials and their practical applications. • Understand the various structural changes occurred in metals with respect to time temperature transformations. • Understand the significance of Fe-C and TTT diagram for controlling the desired structure and properties of the materials.

Detailed Content:

Module 1: Crystallography: Atomic structure of metals, atomic bonding in solids, crystal structures,crystallattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and noncrystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and nonsteady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery,re-crystallization. **12 Hrs**

Module 2: Phase Transformation: General principles of phase transformation in alloys, phase ruleandequilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagramand various phase transformations. Time temperature transformation curves (TTT
curves): fundamentals, construction and applications. **09 Hrs**

Module 3: Heat Treatment: Principles and applications. Processes viz. annealing, normalizing,hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening.Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability.Jominy end-quench test. Defects due to heat treatment and
their remedies; effects produced byalloying elements. Composition of alloy steels. **09 Hrs**

Module 4: Ferrous Metals and Their Alloys: Introduction, classification, composition of alloys,effect ofalloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. **06 Hrs**

Text Books:

1. Materials Science and Engineering, Callister Adopted by R. Balasubramaniam , Wiley
2. T. Goel and R.S. Walia, Engineering Materials & Metallurgy.

Reference Books:

1. Sidney H Avner, Introduction to Physical Metallurgy, Tata Mcgraw-Hill.
2. V. Raghavan, Physical Metallurgy: Principles and Practice, PHI Learning.
3. Y. Lakhin , Engineering Physical Metallurgy, Mir Publishers

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ME-405: Theory of Machines-II

Course Objectives:	• To develop competency in understanding of theory of all types of gears. • To understand the analysis of gear train. • To develop competency in drawing the cam profile. • To make the student conversant with synthesis of the mechanism. • To understand step-less regulations. • To understand mechanisms for system control – Gyroscope.
Course Outcomes:	*After studying this course, students will be able to:* • Understand the basic concepts of inertia forces & couples applied to reciprocating parts of a machine. • Understand balancing of rotating and reciprocating parts of machines. • Select suitable type of gears for different application and analyse the motion of different elements of gear trains. • Understand the concept and application of gyroscopic effect. • Gain knowledge of kinematic synthesis.

Detailed Contents:

Module 1: Static force analysis: Concept of force and couple, free body diagram, condition ofequilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces. **05 Hrs**

Module 2: Dynamic force analysis Determination of forces and couples for a crank, inertia ofreciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four-bar linkage. **05 Hrs**

Module 3: Balancing: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses,and condition of balance in multi cylinder in line V-engines, concept of direct and reverse crank, balancing of machines, rotors, reversible rotors. **06 Hrs**

Module 4: Gears: Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and
efficiency of spiral gears. **07 Hrs**
Gear Trains: Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel. **05 Hrs**

Module 5: Gyroscopic motion and couples: Effect on supporting and holding structures of machines.stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles.

03 Hrs

Kinematic synthesis of Mechanism: Freudenstien equation, Function generation errors insynthesis, two- and three-point synthesis Transmission angles, least square technique.

05 Hrs

Text Books:

1. S.S. Rattan, Theory of Machines, Tata Mc. Graw Hill.
2. John, Gordon, and Joseph, Theory of Machines and Mechanisms, Oxford University Press.

Reference Books:

1. Hams Crone and Roggers, Theory of Machines.
2. Shigley, Theory of Machines, Mc Graw Hill.
3. V.P. Singh, Theory of Machines, Dhanpat Rai and Sons.

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ME-401P: Applied Thermodynamics - II Lab

Course Objectives:	• The usage of fundamental knowledge on thermodynamic cycles and fluid dynamics phenomena present in turbomachinery and combustion for producing electric and mechanical energy/power. • To study Petrol and Diesel engines • To study boilers
Course Outcomes:	*After studying this course, students will be able to:* • Understand the construction and working of IC engines, and evaluate their performance. • Identify the various types of boilers & condensers.

List of Experiments:

1 Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines and to plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine.

2 Study of working, construction, mountings and accessories of various types of boilers.

3 To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.

4 Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.

5 Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).

6 Performance testing of a Petrol and Diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emission. Draw/obtain power consumption and exhaust emission curves. Also make the heat balance sheet.

Text Books: -

1. V. Ganeshan ,"Internal Combustion Engines", Tata McGraw Hill Pvt. Ltd.,7 West Patel Nagar, New Delhi-110 008.
2. VP Vasandani and DS Kumar, "Heat Engineering"; Metropolitan Book Co. Pvt Ltd., Delhi.

Reference Books: -

1. Cohen H and Rogers GFC, "Gas Turbine Theory"; Longmans
2. V Kadambi, Manohar Prasad, "An Introduction to Energy Conversion", Wiley Eastern Ltd, AB and Safdarjang Enclave, New Delhi

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ME402P: Fluid Machines Lab

Course Objectives:	This course offers basic knowledge on fuild statics, dynamics and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery
Course Outcomes:	*After studying this course, students will be able to:* • Conduct experiments on scaled down models or on actual size hydraulic machines and evaluate results in terms of unit or specific quantities for comparison purpose. • Understand the working of various hydraulic machines (turbines and pumps) and can suggest remedial solutions for various faults.

List of Experiments:

1 Determination of various efficiencies of Hydraulic Ram
2 To draw characteristics of Francis turbine/Kaplan Turbine
3 To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance
4 To draw the characteristics of Pelton Turbine
5 To draw the various characteristics of Centrifugal pump
6 A visit to any Hydroelectric Power Station

Text Books:

1. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,

Reference Books:

1. K. Subramaniam, Hydraulic Machines, Tata Mc Graw Hill
2. R.K. Purohit., Hydraulic Machines, Scientific Publishers

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ME404P: Materials Engineering Lab

Course Objectives:	Introduce the concept of structure property relations. Develop intuitive understanding of the subject to present a wealth of real world engineering examples to give students a feel of how material science is useful in engineering practices.
Course Outcomes:	*After studying this course, students will be able to:* 1. Analyse the microstructure of different ferrous and non-ferrous samples. 2. Explore the effect of heat treatment on various engineering materials by analysing its microstructure and hardness.

List of Experiments:

1 Preparation of models/charts related to atomic/crystal structure of metals.

2 Hardening/Annealing of steel specimen and study the effect of quenching time/annealing time and temperature on hardness of steel.

3 Practice of specimen preparation (cutting, mounting, polishing, etching) of mild steel, Aluminium and hardened steel specimens.

4 Study of the microstructure of prepared specimens of Mild Steel, Aluminium and hardened steel.

5 Identification of ferrite and pearlite constituents in given specimen of milsteel.

6 Determination of hardenability of steel by Jominy End Quench Test.

Text Books:

1. Materials Science and Engineering, Callister Adopted by R. Balasubramaniam , Wiley
2. T. Goel and R.S. Walia, Engineering Materials & Metallurgy.

Reference Books:

1. Sidney H Avner, Introduction to Physical Metallurgy, Tata Mcgraw-Hill.
2. Y. Lakhin , Engineering Physical Metallurgy, Mir Publishers

5TH SEMESTER

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ME501: Heat Transfer

Course Objectives	To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications
Course Outcomes	1. To teach students the basic principles of conduction, radiation, and convection heat transfer. Students will demonstrate an understanding of the basic concepts of conduction, radiation, and convection heat transfer. 2. To extend the basic principle of conservation of energy to systems that involve conduction, radiation, and heat transfer. Students will demonstrate an understanding of the concept of conservation of energy and its application to problems involving conduction, radiation, and/or convection heat transfer. 3. To train students to identify, formulate, and solve engineering problems involving conduction heat transfer.

Detailed Contents:

Module 1:

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

Conduction: Fourier's law of heat conduction. Coefficient of thermal conductivity. Effect of temperature and pressure on thermal conductivity of solids, liquids and gases. Three-dimensional general conduction equations in rectangular, cylindrical and spherical coordinates.

Steady State one-dimensional Heat conduction-: Deduction of one-dimensional steady state heat conduction equation in rectangular; cylindrical and spherical coordinates with and without internal heat generation for uniform thermal conductivity of material. Concept of variable thermal conductivity. Conduction shape factor. Conduction through edges and corners of walls. Critical thickness of insulation layers on electric wires and pipes carrying hot fluids.

Module 2:

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

Theory of Fins: Concept of fin. Classification of fins and their applications. Straight fins of uniform cross-section. Individual and total fin effectiveness and efficiency. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement.

Module 3:

Convection: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow. Dimensional analysis as a tool for experimental investigation. Buckingham Pi Theorem and method. Application for developing semi-empirical, non- dimensional correlation for convection heat transfer, Significance of non-dimensional numbers. Concepts of continuity, momentum and energy Equations.

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer. -Flat plates and Cylinders. Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths Division of internal flow based on this Use of empirical relations for Horizontal Pipe Flow and annulus flow.
Natural Convection: Physical mechanism of natural convection. Buoyant force. Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere. Combined free and forced convection

Module 4:

Heat Exchanger: Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers.
Condensation and Boiling Boiling: Definition and types of boiling. Different regimes and heat transfer during pool boiling of a liquid. Nucleation and different theories accounting for increased heat transfer coefficient during nucleate phase of boiling. Condensation: Definition and types of condensation, film wise condensation on a vertical and inclined surface.

Module 5:

Thermal Radiation: Process of heat flow due to radiation. Definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies. Plank's law of non chromatic radiation. Wien's displacement law. Kirchhoff's law. Stefan Boltzmann's law. Lambert's Cosine law. Definition of intensity of Radiation, irradiation and radiosity. Geometric/ configuration factor and its use in heat exchange between two black bodies. Electrical network analysis for radiation exchange between two, three or four bodies (e.g. boiler or other furnaces). Simplification of electrical network analysis for its application to simple bodies like two parallel surfaces, concentric cylinders/spheres and a body enveloped by another body. Use of radiation shields.

Text books:

1. Kumar, D.S. "Fundamentals of Heat and Mass Transfer", S K Kataria & Sons, 7th Edition, 2013.
2. Cengel, A. Yunus, "Heat and Mass Transfer", Tata McGraw Hills Education Private Ltd, 4 th Edition, 2013.

Reference Books:

1. Incropera F.P. and De Witt D.P., "Fundamentals of Heat and Mass transfer", John Wiley, 7th Edition, 2011.
2. Chapman. A. J, "Heat Transfer", McGraw Hill, 7th Edition, 1990.
3. Holman, J.P. "Heat Transfer", Tata McGraw-Hill Publishing Company Ltd, 9th Edition, 2008

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ME-502: Design of Machine Elements

Course Objectives	To motivate and challenge students to understand and develop an appreciation of the processes in correlation with machine properties which change the shape, size and form of the raw materials into the desirable product by machine elements
Course Outcomes	*After studying this course, students will be able to:* • Learn the functioning and performance evaluation of Bearings. • Analyze the processes of Clutches, flywheel.

Detailed Contents:

Module 1

Transmission Drives
Belt and rope drives: Basics, Characteristics of belt drives, selection of flat belt, Design of Flat belt, V-belt and rope (steel wire), Design of the pulley for the same
Chain Drives: Basics, Roller chains, polygonal effect, power rating, selection of chain
Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, terminology of spur, helical, bevel, worm and worm wheel, Design of spur, helical, straight bevel gears, worm and worm wheel

Module 2

Bearings
Slider: Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design
Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of roller and slider bearing

Module 3.

Design of Flywheel
Introduction, Energy stored in a flywheel, stresses in a rim, design considerations

Module 4.

Springs
Types; end styles of helical compression spring; stress and deflection equation; surge in spring; nipping of leaf spring; Design of close-coil helical spring and multi leaf spring.

Module 5

Clutches and Brakes
Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches. Design of band, disc, block with shoe and internal expanding brakes.

Text books:

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
2. Robert C. Juvinall Fundamentals of machine component design, JohnWiley Eastern
3 V.K Jadon, Analysis and design of machine elements, I.K. International

Reference Books:

1. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill
2. S.S Jolly, Design of machine elements-II, Dhanpat Rai and Co.

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ME503: Manufacturing Processes

Course Objectives	To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.
Course Outcomes	Upon completion of this course, students will be able to understand the different conventional and unconventional manufacturing methods employed for making different products. To train students to identify, formulate, and solve engineering problems involving forced convection heat transfer, natural convection heat transfer, and heat exchangers. Students will also demonstrate an ability to analyze the performance of heat exchangers

Detailed Contents:

Module 1:

Conventional Manufacturing Processes:

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.

Module 2:

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Additive manufacturing:

Rapid prototyping and rapid tooling

Module 3:

Joining/fastening processes:

Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

Module 4:

Unconventional Machining Processes:

Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters.

Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant &maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining

Module 5:

Tooling

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Text Books:

1. Rao P N, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
2. Kalpakjian S and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.
3. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
4. Ghosh A, & Mallik A K 1986. Manufacturing science: Ellis Horwood.

Reference Books:

1. Campbell J S, Principles of manufacturing materials and processes: Tata McGraw-Hill
2. Shan H S, Manufacturing Processes, Vol. I, Pearson Publishers.
3. Little, Welding and Welding Technology, McGraw-Hill Education (India) Pvt Ltd.
4. NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112 web and video resources on Manufacturing Processes I

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ME-504: Management and Engineering Economics

Course Objectives	i. Acquire knowledge of economics to facilitate the process of economic decision making ii. Acquire knowledge on basic management aspects
Course Outcomes	On completion of this subject students will be able to 1. Explain the development of management and the role it plays at different levels in an organization. 2. Comprehend the process and role of effective planning, organizing and staffing for the development of an organization. 3. Understand the necessity of good leadership, communication and coordination for establishing effective control in an organization. 4. Understand engineering economics demand supply and its importance in economics decision making and problem solving. 5. Calculate present worth, annual worth and IRR for different alternatives in economic decision making. 6. Understand the procedure involved in estimation of cost for a simple component, product costing and depreciation, its methods.

Detailed Contents:

Module 1

Management Introduction: Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought early management approaches – Modern management approaches.
Planning: Nature, importance and purpose of planning process Objectives -Types of plans (Meaning Only) Decision making Importance of planning -steps in planning & planning premises - Hierarchy of plans.

Module 2

Organizing and Staffing
Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing: Process of Selection & Recruitment (in brief).
Directing & Controlling:
Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief)
Module 3: **Introduction**
Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems

Module 4: **Present, future and annual worth and rate of returns**

Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems.

Module 5: **Costing and Depreciation:**

Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

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Text Books:

1. Principles of Management by Tripathy and Reddy
2. Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015
3. Engineering Economy, Riggs J.L. McGraw Hill, 2002
4. Engineering Economy, Thuesen H.G. PHI , 2002

Reference Books

1. Management Fundamentals- Concepts, Application, Skill Development - RobersLusier - Thomson
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Engineering Economics, R.Paneerselvam, PHI publication

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ME501P: Heat Transfer Lab

Course objectives:	To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications
Course Outcomes:	After undergoing this course, students shall be able to: 1. Design and fabricate the experimental setups related to heat transfer phenomena. 2. Measure and analyse different heat transfer parameters. 3. Apply finite difference methods to solve simple heat transfer problems.

Detailed contents:

Two to three students in a group are required to do one or two practicals in the form of Lab. Project in the topic/s related to the subject matter of Heat Transfer and in consultation with teacher.

Minimum twelve experiments from the following:

1. Composite Slab Apparatus – Overall heat transfer co-efficient.
2. Heat transfer through lagged pipe.
3. Heat Transfer through a Concentric Sphere
4. Thermal Conductivity of given metal rod.
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.
11. Stefan Boltzman Apparatus.
12. Critical Heat flux apparatus.
13. Study of heat pipe and its demonstration.
14. Film and Drop wise condensation apparatus

Text books:

1. Kumar, D.S. “Fundamentals of Heat and Mass Transfer”, S K Kataria & Sons, 7th Edition, 2013.

Reference Books:

1. Holman, J.P. “Heat Transfer”, Tata McGraw-Hill Publishing Company Ltd, 9th Edition, 2008

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ME503P: Manufacturing Processes Lab

Course objectives:	To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.
Course Outcomes:	After studying this course, students shall be able to: 1. Determine/calculate the clay content, moisture content, hardness, permeability and grain fineness number of moulding sand sample. 2. Use oxy-acetylene gas welding, manual arc welding, MIG, TIG and spot-welding processes to make various joints. 3. Use machine tools such as lathe, shaper and milling machine for machining/cutting various profiles on work pieces. 4. Learn about the constructional features and working of grinding machines, hydraulic press, draw bench, rolling mills, drawing and extrusion equipment.

Detailed Contents:

Casting

1. To determine moisture content and hardness of a moulding sand sample.
2. To determine permeability and grain fineness number of a moulding sand sample.

Welding

1. To make lap joint, butt joint and T- joints with oxy- acetylene gas welding and manual arc welding processes
2. To study MIG, TIG and Spot-welding equipment and make weld joints by these processes.

Machining and Forming

1. To study constructional features of following machines through drawings/ sketches:

a. Grinding machines (Surface, Cylindrical)

b. Hydraulic Press

c. Draw Bench

d. Drawing and Extrusion Dies

e. Rolling Mills

2. To grind single point and multipoint cutting tools
3. To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.
4. To prepare job on shaper involving plane surface,
5. Use of milling machines for generation of plane surfaces, spur gears and helical gears; use of end mill cutters.

Text Books:

1. Rao P N, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
2. Kalpakjian S and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.

Reference Books:

1. Campbell J S, Principles of manufacturing materials and processes: Tata McGraw-Hill
2. NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112 web and video resources on Manufacturing Processes I

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ME505P: Numerical Methods Lab

Course Objectives	This course provides understanding of implementations of basic numerical methods for solving different problems *viz.* nonlinear equations, system of equations, numerical integration and ordinary differential equations etc. The basic objective of this course is to develop capability of programming of numerical methods in the students so that they can develop and implement their own computer programs of the methods for solving different problems arising in science, engineering and technology etc.
Course Outcomes:	After completion of this course, the students will be able to: iii. Understand different implementation modes of numerical methods. iv. Use the numerical methods with the understanding of limitations of these methods for solving problems. v. Develop and implement their own computer programs. vi. Solve problems more accurately and efficiently in low computational time.

Detailed Contents:

List of experiments:

1. Make a program of bisection method for solving algebraic/transcendental equations and implement it on some problems.
2. Develop a program of Newton-Raphson's method for solving algebraic/transcendental equations and implement it on some problems.
3. Develop and implement a program of Method of False Position forsolving algebraic/transcendental equations.
4. Develop and implement a program of Gauss-elimination method for solving a system of linear equations.
5. Develop and implement a program of trapezoidal rule to approximate a definite integral.
6. Develop and implement a program of Simpson's rule to approximate a definite integral.
7. Develop and implement a program of Euler's method for solving initial value problems of ordinary differential equations.
8. Develop and implement a program of fourth order Runge-Kutta method for solving initial value problems of ordinary differential equations.

Text Books:

1. Introduction To C Programming & Numerical Methods Lab by Sanjoy Mondal,

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MC102: Essence of Indian Knowledge Tradition

Course Objective:	The course aims at imparting basis principals of thought process. Reasoning and inferencing Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit Literature are also important in modern society with rapid technological advancements and societal disruptions Part-1 focuses on introduction to Indian Knowledge System. Indian perspective of modern scientific world -view and basis principal of Yoga and holistic health care system
Course Outcomes:	The course outcomes at imparting basis principals of thought process. Reasoning and inferencing Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit Literature are also important in modern society with rapid technological advancements and societal disruptions Part-2 focuses on Indian philosophical traditions. Indian linguistic Tradition, and Indian artistic tradition

Detailed Contents:

Module 1

i. Basic Structure of Indian Knowledge system
ii. Modern Science and Indian Knowledge system
iii. Yoga and Holistic Health Care
iv. Case studies

Module 2

i. Fritzof Capra Too of Physics
ii. Fritzof Capra The Wave of life
iii. Yoga Sutra of Patanjali. Ramakrishna Mission. Kolkata.
iv. RN Jha Science of Consciousness Psychotherapy and Yoga Practices. Vidyanidhi Prakashan. Delhi2016
v. PB Sharma (English translation) ShodashangHridayam

Module 3

Pedagogy: Problem based learning, group discussion, collaborative mini projects

Outcome: Ability to understand connect up and explain basics of Indian traditional Knowledge in Modern scientific perspective.

Module 4

i. Philosophical Tradition
ii. Indian Linguistic Tradition (Phonology, morphology, syntax and semantics)
iii. Indian Artistic Tradition
iv. Case studies

Text books :

1 V.Sivaramakrishnan (Ed.), Cultural Heritage of India-Course material, Bhartiya Vaidya Bhawan Mumbai 5th Edition 2014

2 S.C Chaterjee &D.M .Datta , An introduction to Indian Philosophy ,University of Calcutta 1984 KS Subrahmanialyer ,Vakyapadiya of Bhattaraihari (Brahma Kanda), Deccan College Pune 1965

3 VN Jha, Language Thought and Reality

REFRENCE BOOKS:

1 Pramod Chandra. India Arts Howard Univ. Press 1983

2 Krishna Chaitanya Arts of India. Abhinav Publications. 1987

3 R Nagaswamy , Foundations of Indian Art Tamil Arts Academy

6TH SEMESTER

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ME-601: Refrigeration and Air Conditioning

Course objectives:	To introduce the students, the basic refrigeration cycles of various refrigeration systems. To impart the students with basic understanding of and air conditioning systems for different climatic seasons. To give the basic understanding of design aspects of RAC components such as evaporators, condensers, capillary tubes, expansion valve etc.
Course Outcomes:	After undergoing this course, the student will: 1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system 2. Obtain cooling capacity and coefficient of performance by conducting test on refrigeration systems. 3. Calculate the energy requirements of cooling and heat equipment for air conditioning applications. 4. Explain the properties, applications and environmental issues of different refrigerants. 5. Demonstrate an ability to analysis psychrometric processes and cycles of air conditioning systems.

Detailed Contents:

Module 1. Basic Concepts

Classification of refrigeration systems, Refrigeration effect, cooling capacity, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy Performance Ratio; Single Phase Reversed Carnot cycle and its limitations; Two Phase Reversed Carnot cycle and its limitations.

Vapour Compression Refrigeration Cycles

Modifications of reversed Carnot cycle with vapour as a refrigerant, Vapour compression refrigerationcycle & system; Representation of this cycle on P-V, T-S and P-H diagrams and its analysis using T-S and Ph diagrams and Refrigeration Tables for sub cooled, saturated and superheated refrigerant, volumetric efficiency of compressor; Effect on performance of VCRS due to change in evaporator pressure, condenser pressure, sub cooling of liquid refrigerant, super heating of suction vapours; Actual vapour compression refrigeration cycle on T-sand P-h diagrams (no mathematical analysis); Numerical problems. Compound compression with single evaporator, Multi evaporators with single compressor, along with schematic representation of these systems with use of flash chamber, water intercooler, flash intercooler, with individual and multiple expansion valves arrangements. (Without numerical problems).

Module 2. 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; Zeotropes; Effect of moisture and oil miscibility; Antifreeze solution; Leak detection and charging of refrigerants; Environmental aspects of conventional refrigerants; Eco-friendly refrigerants and action plan to reduce ecological hazards.

Module 3. Vapour Compression Refrigeration System Components

Classifications and working of Compressors, Condensers, Expansion devices and Evaporators. Performance characteristics of the condensing unit, Performance characteristics of the compressor capillary tube.

Vapour Absorption Refrigeration Cycles

Principle of vapour absorption refrigeration; basic components of the vapour absorption refrigeration system; Desirable properties of absorption system refrigerant and absorbent; Aqua - ammonia vapour absorption refrigeration system; Lithium Bromide - water absorption system; Electrolux refrigeration system; comparison between vapour absorption and compression systems (no mathematical analysis).

Module 4. Psychrometry

Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychometric properties of air: Dry bulb, wet bulb and dew point temperatures, Relative and specific humidity, degree of saturation adiabatic saturation temperature, enthalpy of air and water vapours; Psychometric chart and its use; Numerical problems. Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning.

Psychometric Processes

Basic psychometric processes; Adiabatic mixing of two air streams Sensible heating; Sensible cooling; cooling with dehumidification; cooling with humidification; Heating with dehumidification; Heating with humidification; By-pass factor; Contact factor; Sensible heat factor; Room sensible heat factor; Grand sensible heat factor.

Module 5. Air conditioning Load Calculations

Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Apparatus dew point temperature; Rate and state of supply air for air conditioning of different types of premises.

Text Books:

1. C.P. Arora, Refrigeration and Conditioning, Tata McGraw Hill
2. Manohar Prasad, Refrigeration and Conditioning, Wiley Eastern Limited

Reference Books:

1. Jordan and Priester, Refrigeration and Conditioning, Prentice Hall of India
2. W.F. Stoecker, Refrigeration and Conditioning, McGraw Hill

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ME602: Mechanical Measurements and Metrology

Course objectives:	1. To provide a knowledge about measurement systems and their components 2. To learn about various sensors and transducers used for measurement of mechanical quantities 3. To learn about usage of various measuring instruments 4. To learn metrology of screw, gear and surface texture
Course outcomes:	After undergoing this course, the student will be able to: 1. Interpret characteristics of measuring instruments. 2. Describe various industrial metrological instruments for measuring linear, angular, screw thread and gear profiles. 3. Apply the fundamental principles for measurement of various mechanical quantities like Force/torque etc.

Detailed Contents:

Module1: MECHANICAL MEASUREMENT SYSTEMS:

Need of mechanical measurement, basic and auxiliary functional elements of a measurement system Basic definitions: Hysteresis, Sensitivity, Linearity, Resolution, Threshold, Drift, Zero stability, loading effect and system response. Dead Time and dead zone, Measurement methods, Generalized Measurement system, Static performance characteristics, Errors and their classification.

Module2 SENSORS AND TRANSDUCERS:

Introduction to sensors and transducers, types of sensors, review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pickups, photo cells and piezoelectric transducers, Introduction to signal processing and conditioning.

Module3 LINEAR AND ANGULAR MEASUREMENTS:

Vernier calliper, Micrometer, Interval measurements: Slip gauges, Checking of slip gauges for surface quality, Optical flat, Limit gauges.

DISPLACEMENT, VELOCITY/SPEED AND ACCELERATION MEASUREMENT:
Working principal of Resistive Potentiometer, Linear variable differential transducers (LVDT), Electro- Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer,

Module 4. TEMPERATURE MEASUREMENT:

Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices.

Module5. METROLOGY:

Basics of Metrology, Line end and wavelength standards, Need for Inspection, Accuracy and Precision, Objectives, Standards of measurements.

METROLOGY OF SURFACE FINISH:
Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, Wave length, frequency and cut off, other methods for measuring surface roughness: Light Interference microscopes, Mecrin Instruments

Text Books:

1. D.S Kumar, Mechanical Measurement and Control, Metropolitan Book Co.

2. A Textbook of Measurement and Metrology, A.K. Sawhney, Dhanpat Rai & Co

Refrence books:

1. R.K Jain, Engineering Metrology, Khanna Publishers
2. W.F. Stoecker, Engineering Metrology Rawat Publishers

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ME603: Automobile Engineering

Course objectives:	• To understand the construction and working principle of various parts of an automobile. • To have the practice for assembling and dismantling of engine parts and transmission system
Course Outcomes:	After undergoing this course, the student will be able to: 1. Identify the different parts of the automobile. 2. Explain the working of various parts like engine, transmission, clutch, brakes, steering and the suspension systems. 3. Develop a strong base for understanding vehicle safety systems and future developments in the automobile industry

Detailed Contents:

Module 1. Introduction
Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit.
Power Unit Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system., turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

Module 2. Fuel Supply System
Air cleaner and fuel pumps; Air fuel requirements and carburation; constructional details of fuel injection systems (MPFI) used in Indian make vehicles. Diesel fuel system (IDI, DI & CRDI) - cleaning, injection pump, injector and nozzles. Introduction to Gasoline Direct Injection and dual fuel supply systems.
Lubrication and Cooling Systems
Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling: air-cooling and water-cooling systems; radiator, thermostat, pump and fan.
Module 3. Chassis and Suspension
Loads on the frame, considerations of strength and stiffness, engine mounting, conventional and independent suspension systems; adaptive suspension systems; shock absorbs and stablisers; wheels and tyres.

Transmission system
Basic requirements and components of transmission systems; constructional features of automobile clutch, gear boxes & types, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission. Types of automatic transmissions (Torque convertor AT, AMT, CVT, DCT/DSG). Traction control system.

Module 4.
Steering System

Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel balancing & alignment; power steering (electrical and hydraulic).

Braking System

General braking requirements; Weight transfer during braking and stopping distances; Mechanical, hydraulic, vacuum power and servo brakes; Adaptive cruise control and braking system

Electric System

Conventional (coil and magneto) and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation

Module 5. Vehicle safety systems

Active and passive safety systems in an automobile. Air bags, collapsible steering system, seat belts, side impact rods, crumple zones etc. ABS & EBD, ESP, diver alert system.

Alternative Energy Sources

Concept and types of electric & Hybrid Vehicles. Fuel cell technology,Use of Natural Gas, Liquefied Petroleum Gas, Biodiesel, Bioethanol, Gasohol andHydrogen in Automobiles- Engine modifications required –Performance

Maintenance

Preventive maintenance, trouble shooting and rectification in different systems; engine turning and Servicing

Text BOOKS:

1. J. Webster, Auto Mechanics, Glencoe PublishingCo.
2. P.S Gill, Automobile Engineering, S.KKataria

Reference Books:

1. W.H Crouse, Automotive mechanics, McGrawHill
2. J. Heitner, Automotive Mechanics, East WestPress
3. Kirpal Singh, Automobile Engineering Vol. I and II, StandardPublishers

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ME604: Introduction to Industrial Management

Course objectives:	• To help the students gain understanding of the functions and responsibilities of industrial managements. • To enable them to analyze and understand the environment of the organization. • To help the students to develop cognizance of the importance of management principles. • To provide them tools and techniques to be used in the performance of the managerial job.
Course Outcomes:	• Understand the complexities associated with management in the organizations and integrate the learning in handling these complexities. • Demonstrate the roles, skills and functions of management. • Understand the concepts related to industrial management.

Detailed Contents:

Module 1:
Concept of industrial engineering, Roles of industrial engineer, Tools of management science, Introduction to quality, Excellence in manufacturing, Excellence in service, factors of excellence, relevance of total quality management.
Concept of production, Production system, Input output model, definition of quality, Total quality control and Total Quality Management, salient features of total quality control and total quality management, benefits of total quality management.

Module 2: Introduction to product design, Effect of design on cost, Requirements of a good product design, Factors affect product design, Product life cycle, Need and concept of product planning, Concept of product development. Introduction of industrial cost, Elements of cost, Breakeven analysis.
Materials management, Purchasing, Objectives of purchasing, Activities, duties and functions of purchasing department, Purchase organizations, Buying techniques, Purchasing procedure.

Module 3: Concept of plant maintenance, Objectives and importance of plant maintenance, Duties, functions and responsibilities of plant maintenance department, Organization of maintenance, Scheduled, preventive and predictive maintenance.
Module 4: Inventory, Inventory control, Objectives of inventory control, ABC analysis, Just-in-time (JIT), Definition: Elements, benefits, equipment layout for JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation.

Module -5:

Benchmarking: Meaning of benchmarking and its concept, Definition of benchmarking, Benefits of bench marking, process and types of benchmarking.

Customer: Types of customers, Customer satisfaction, Role of marketing, Data collection, Customer complaints, Redressal mechanism.

Text Books:

1. Industrial Engineering and Management/ O. P. Khanna/ Dhanpat Rai and Sons
2. Industrial Engineering and Production Management/ Telsang Marland T. / S. Chand

Reference Books:

1. *Handbook of Industrial Engineering* by Gavriel Salvendy
2. *Industrial Press Machinery's Handbook* by Erik Oberg

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MC601: Constitution of India

Course objectives:	• The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. • The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Courtof India in its historical judgments. job.
Course Outcomes:	• The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. • The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Courtof India in its historical judgments.

Detailed Contents:

Module 1: Introduction

The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America andparticularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America

Module 2:

Meaning of the constitution law and constitutionalism Historical perspective of the Constitution of India Salient features and characteristics of the Constitution of India Scheme of the fundamental rights.

Module 3:

The scheme of the Fundamental Duties and its legal status

The Directive Principles of State Policy – Its importance and implementation Federal structure and distribution of legislative and financial powers between the Union and the States

Module 4:

Parliamentary Form of Government in India – The constitution powers and status ofthe President of India.Amendment of the Constitutional Powers and Procedure The historical perspectives of the constitutional amendments in India Emergency

Module 5:

Provisions : National Emergency, President Rule, Financial EmergencyLocal Self Government – Constitutional Scheme in India
Scheme of the Fundamental Right to Equality
Scheme of the Fundamental Right to certain Freedom under Article 19Scope of the Right to Life and Personal Liberty under Article 21

Text Books:

1. Introduction to the Constitution of India by D D Basu\
2. The Constitution of India by Dr. B.R Ambedkar

Reference Books:

1. The Indian Constitution Cornerstone of A Nation by Austin Granville
2. The Constitution Of India Bare Act by Dr. P.K. Agrawal & Virag Gupta

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ME601P: Refrigeration and Air Conditioning Lab

Course Objectives:	To introduce the students for hand on practice to perform the experiment and evaluate the experimentalrecord pertaining to refrigeration cycles of various refrigeration systems. To impart the students with training of interfacing the theoretical and practical skills. Refrigeration and Air Conditioning and its primary components such as evaporators, condensers, capillary tubes, expansion valve etc.
Course Outcomes:	1. Conduct and analyze the experimental data of performance of vapour compression refrigeration system in domestic refrigerator and water cooler. 2. Conduct and analyze the experimental data of performance of Electrolux Refrigerator. 3. Conduct the performance of window type room air conditioner and system. 4. Analyze the industrial set up for the working and use of vapour compression refrigeration system in cold storage.

List of Experiments

1. Demonstration of various elements of a vapour compression refrigeration system through refrigeration trainer.
2. Performance testing of domestic refrigerator using refrigeration test rig.
3. Performance testing of Electrolux refrigerator.
4. Study of an Ice plant.
5. Calculation/ Estimation of cooling load for a large building.
6. Visit to a central air conditioning plant for the of study air-conditioning system.
7. Visit to a cold storage for study of its working..

Text Books:

1. C.P. Arora, Refrigeration and Conditioning, Tata McGraw Hill
2. Manohar Prasad, Refrigeration and Conditioning, Wiley Eastern Limited

Reference Books:

1. Jordan and Priester, Refrigeration and Conditioning, Prentice Hall of India
2. W.F. Stoecker, Refrigeration and Conditioning, McGraw Hill

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ME602P: Mechanical Measurement and Metrology Lab

Course Objectives:	To introduce the students for hand on practice to perform the experiment and evaluate the experimental record pertaining To impart the students with training of interfacing the theoretical and practical skills. The student will be able to: 1. Demonstrate the use of instruments for measuring linear (internal and external), angular dimensions and surface roughness. 2. Apply analytical and experimental methods to make measurements and to find and correct defects in measurement systems
Course Outcomes:	1. Conduct and analyze the experimental data of performance metrology lab. Analyze the industrial set up for the working and use of measurement systems . 2. Identify proper measuring instrument and know requirement of calibration, errors in measurement etc.

List of experiments:

1. Vernier Calliper/ vernier height gauge: Principle of vernier scale to measure internal and external
dimensions including depth
2. Micrometer and vernier micrometer: concept, principle and use
3. Sine bar and slip gauges and angle gauge: principle and applications
4. Surface texture: Roughness of machined and un-machined plane and spherical surfaces
5. Profile projector: to measure screw and gear elements
6. Tool makers microscope: to measure screw and gear elements
7. Stroboscope: measure speed of rotating elements
8. Thermocouple: principle, applications and preparation

Text Books:

1. D.S Kumar, Mechanical Measurement and Control, Metropolitan Book Co.

2. A Textbook of Measurement and Metrology, A.K. Sawhney, Dhanpat Rai & Co

Refrence books:

1. R.K Jain, Engineering Metrology, Khanna Publishers
2. W.F. Stoecker, Engineering Metrology Rawat Publishers

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ME603P: Automobile Engineering Lab

Course Objectives:	The student will be able to: 1. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems. 2. Understand importance and features of different systems like axle, differential, brakes, steering, suspension, and balancing etc. 3. Identify Modern technology and safety measures used in Automotive Vehicles
Course Outcomes:	After undergoing this course, the student will be able to: 1. Identify the different parts of the automobile. 2. Explain the working of various parts like engine, transmission, clutch, brakes, steering and the suspension systems. 3. Develop a strong base for understanding vehicle safety systems and future developments in the automobile industry

List of Experiments

1. Valve prefacing and valve seat grinding and checking for leakage of valves
2. Trouble shooting in cooling system of an automotive vehicle
3. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap
4. Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
5. Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.
6. Fault diagnosis in transmission system including clutches, gear box assembly and differential.
7. Replacing of ring and studying the method of replacing piston after repair.
8. Dismantling and assembling of diesel and petrol engine.
9. Study of cut section model of Petrol and diesel engine.

Text BOOKS:

1. J. Webster, Auto Mechanics, Glencoe PublishingCo.
2. P.S Gill, Automobile Engineering, S.KKataria

Reference Books:

1. W.H Crouse, Automotive mechanics, McGrawHill
2. J. Heitner, Automotive Mechanics, East WestPress
3. Kirpal Singh, Automobile Engineering Vol. I and II, StandardPublishers

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ME-605: Minor Project

Course Objectives:	The project work will be carried out in parts as minor project in 6th semester and major project in 7th semester. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology for the project shall be decided in 6th semester. The same project problem is to be extended in the major project in semester. The minor project may be carried out by a group of students 2 to 5.
Course outcomes:	• Students will demonstrate advanced practical knowledge among companies. • Students will be able to analyze practical work. • Student detects the problems regarding their specializing fields very easily . • The abilty to understand or to capture problems by the students very practically. • Practical Knowledge skills of students better.

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ME606: Computer Aided Design

Course Objectives:	To provide an overview of how computers can be utilized in mechanical component design
Course outcomes:	Upon completion of this course, the students can use computer and CAD software for modeling mechanical components

Detailed Contents:

Module I
Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation

Module II
Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep.

Module III
Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation
Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking

Module IV

CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics
Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

Text Books:
1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.

Reference Books:

1. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.
2. D. Hearn and M.P> Baker, Computer Graphics, Prentice Hall Inc., 1992.

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ME607: Manufacturing Technology

Course Objectives:	1. To provide knowledge on machines and related tools for manufacturing various components. 2. To understand the relationship between process and system in manufacturing domain. 3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.
Course outcomes:	Upon completion of this course, students will be able to the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components and the application of optimization methods in manufacturing.

Detailed Contents:

Module I
Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Module II
Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and partquality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as microscale machining, Inspection and workpiece quality.

Module III
Assembly practices: Manufacturing and assembly, process planning, selective assembly, Materialnhandling and devices.

Module IV
Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks: CPM and PERT, critical path scheduling; Production planning& control: Forecasting models, aggregate production planning, materials requirement planning.
Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models.

Text Books:
1. A Textbook of Manufacturing Technology By R. K. Rajput
2. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.

Reference Books:

(i) Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

(ii) Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.

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ME608:Non-Conventional Energy Resources

Course Objectives:	Understand the history, global, environmental and economic impacts of green technology Identify Modern technology and safety measures energy resources
Course outcomes:	At the end of the course, the student will be able to: 1. Address smart energy and green infrastructure 2. Build models that simulate sustainable and renewable green technology systems 3. Understand the history, global, environmental and economic impacts of green technology 4. Address nonrenewable energy challenges

Detailed Contents:

Module I
An introduction to energy sources, Environmental Aspects of Power Generation. Heat Transfer from Solar Energy, Physical principles of conversion of solar radiation into heat utilization, Flat Plate Collectors (FPC), Thermal losses and efficiency of FPC, Practical considerations for flat plate collectors, Applications of FPC – Water heating and drying, Focusing Type Collectors: orientation and sun tracking systems, Types of concentrating collectors – cylindrical parabolic collector, compound parabolic collector, Thermal performance of focusing collectors.

Module II
Solar energy storage system, Application of solar energy: solar water heating, space heating and cooling, solar photovoltaic, solar cooking, solar distillation & desalination, Solar industrial process heating, Solar power generation. Solar Green Houses, Solar thermo mechanical power, solar refrigeration & air conditioning, Solar ponds.

Module III
Energy from Biomass: Type of biomass sources, Energy plantation, Methods for obtaining energy from biomass, Biomass conversion technologies-wet and dry processes, Biodigestion, Community/Industrial biogas plants, Factors affecting biodigestion, Design of a biogas plant, Classification, advantages and disadvantages of biogas plants, Problems related to biogas plants, Utilization of biogas. Thermal
gasification of biomass, Gasifier- classification, chemistry, advantages, disadvantages and application. Alcohol fuels from biomass: overview, feedstock, methods for alcohol production, Ethanol as an alternative liquid fuel; engine performance with alcohol fuels, biodiesel from biomass.

Module IV
Wind Energy: Basic principles of wind energy conversion: power in the wind, maximum power, forces on the blades, lift and drag, Components of wind energy conversion systems (WEC), Classification, advantages and disadvantages of WEC systems, Types of wind machines, Performance of wind machines, Design considerations, Energy storage, Application of wind energy, Environmental aspect. Tidal Energy. Components of tidal power plants, Single and double basin arrangements, Estimation of energy and power, Advantages and limitations of tidal power. Wave energy- its advantages and disadvantages, energy and power from wave energy.

Module V

Chemical Energy Sources: Fuel cells: Design, principle, classification, types, advantages and disadvantages, Work output and EMF of fuel cells, Application of fuel cells, Hydrogen energy, Properties of hydrogen, Methods of hydrogen production, Storage and transportation of hydrogen, Advantages and application.

Textbooks:

1. G D Rai, 'Non-Conventional Energy Sources', Khanna Publishers. Delhi, 2010
2. S P Sukhatme, 'Solar Energy-Principles of Thermal Collection & Storage', Tata McGraw Hill Publishing Company Ltd., New Delhi

Reference Books:

1. Non-Conventional Energy Resources by Bansal N.K.
2. Non-Conventional Energy Sources and Utilisation by RK Rajput

7TH SEMESTER

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ME701: Automation in Manufacturing

Course Objectives:	1. To understand the importance of automation in the of field machine tool based manufacturing 2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC 3. To understand the basics of product design and the role of manufacturing automation
Course outcomes:	After undergoing this course, the student will be able to: 1. Interpret characteristics of measuring instruments CAD CAM . 2. Describe various industrial metrological instruments for measuring CAM CIM. 3.. Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations

Detailed Contents:

Module I
Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and

Module II
Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.

Module III
Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods

Module IV
Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNCAdaptive Control Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

Module V
Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

Text Books:

1 Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall
2 SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson

.

REFRENCE BOOKS:

1 YoramKoren, Computer control of manufacturing system, 1st edition
2 Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

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ME702: Power Plant Engineering

Course Objectives:	To provide an overview of power plants and the associated energy conversion issues
Course Outcomes:	Upon completion of the course, the students can understand the principles of operation for different power plants and their economics

Detailed Contents:

Module I: Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam andheating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Module II: Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization,components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Module III
Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Module IV
Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems
Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

Text Books:
1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

Refrence books:
1. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

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ME703: Composite Materials

Course Objectives:	1. To understand the mechanical behaviour of composite materials 2. To get an overview of the methods of manufacturing composite materials
Course Outcomes:	Upon completion of this course, the students will have an overview of the mechanical behaviour and application of composite materials

Detailed Contents:

Module I: Definition and applications of composite materials, Fibers- glass, carbon, ceramic and aramid fibers; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices.

Module II: Lamina- assumptions, macroscopic viewpoint, generalized Hooke;s law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.

Module III:
Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes.

Module IV: Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites,

Module V
prediction of laminate failure, thermal analysis of composite
Laminates Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies

Text Books:
1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill
2. An introduction to composite materials by D. Hull and T.W. Clyne

Refrence books:

(i) The Science And Engineering Of Materials Donald R Askeland

(ii) Composites Manufacturing Materials, product, and process engineering by Sanjay K. Mazumdar

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ME704: Gas Dynamics and Jet Propulsion

Course Objectives:	1. To understand the features of compressible isentropic flows and irreversibilities like shocks. 2. To provide a basic knowledge of jet and rocket propulsion technologies.
Course Outcomes:	Upon completion of this course, the students will be able to apply gas dynamics principles to jet and space propulsion systems

Detailed Contents:

Module I
Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow,

Module II
Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, choked flow, Area-Mach number relations for isentropic flow.

Module III
Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables.

Module IV
Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Module V
Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights.

Text Books:
1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing, 2004.

Refrence books:
1. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
2. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

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ME705: Operation Research

Course Objectives:	The course is designed to understand the mathematical, engineering and modeling skills that may be useful for designing and solving complex industrial/social/economic problems using various optimization models like deterministic and probabilistic models, simulations, queuing theory, inventory model, replacements models and network models, etc.
Course Outcomes:	**1.** Explain various mathematical deterministic operation research models. **2.** Describe the problems of probabilistic and simulation models. **3.** Demonstrate the queuing, inventory and replacement models etc. **4.** Formulate and analyze the network models.

Detailed Contents:

Module I:Introduction
Origin of OR and its role in solving industrial problems: General approach for solving OR problems. Classification of mathematical models: various decision making environments. (2)
Deterministic Models
Formulation of deterministic linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two phase method, Introduction to duality theory and sensitivity analysis: transportation, assignment and sequencing models; Introduction to goal programming; Solution techniques of linear goal programming problems. (6)

Module II: Probabilistic Models
Decision making under uncertainty: Maximum and minimum models; Introduction to decision tree. Game theory: Solution of simple two person zero-sum games: Examples of simple competitive situation. (4)
Simulation: Concept general approach and application. Use of Monte-Carlo simulation technique to queuing and inventory problems. (3)

Module III: Dynamic Programming
Introduction to deterministic and probabilistic dynamic programming. Solution of simple problems. (3)
Queuing Theory
Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations. (4)

Module IV: Replacement Models
Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy. (4)

Module V: Inventory Models
Inventory models: Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, inventory models with price breaks. (4)

Network Models

Shortest route and traveling sales - man problems, PERT & CPM introduction, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction, resource leveling and smoothening. (6)

Text Books:

1. Principles of Operations Research HM Wagner, Prentice Hall.
2. Operations Research PK Gupta and DS Hira, S. Chand & Co.

Reference Books:

1. Introduction to Operation Research Taha
2. Introduction to Operation Research F.S. Hiller and G.I. Libermann, Holden Ray.

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ME706: Maintenance & Reliability

Course Objectives:	This course is designed to introduce basic concepts of maintenance and reliability to the students, to introduce various method of reliability analysis with real time problems with constraints and to make understanding the applications of Reliability and maintenance analysis for different types of systems.
Course Outcomes:	1. Understand the concepts of reliability and maintainability 2. The students will be able to use statistical tools to characterise the reliability of an item and determine the reliability of a system, and will also understand the application of maintenance strategies in a manufacturing environment; 3. The students will develop ability in formulating suitable maintenance strategies to enhance system reliability of a manufacturing system

Detailed Contents:

Module I: Introduction
Objective and characteristics of maintenance function, Organization of the maintenance system, Operating practices in maintenance, Maintenance record keeping.
Cost Aspect of Maintenance:
Costs of machine breakdown, estimation of life cycle costs, Application of work measurement in maintenance, Manpower planning and training, Incentive payments for maintenance.

Module II: Planning of Maintenance Activities:
Evaluation of alternative maintenance policies breakdown, preventive and predictive maintenance, fault diagnosis and condition monitoring techniques, simulation of alternative practices, Development of preventive maintenance schedule, House keeping practices, total productive maintenance.
Maintenance Engineering:
Maintenance requirements of mechanical, electrical, process and service equipment, Safety aspect in maintenance, Aspect of lubrication; chemical control of corrosion, Computerized maintenance information systems.

Module IV: Reliability
Concept and definition, configuration of failure data, various terms used in failure data analysis in mathematical forms, component and system failures, uses of reliability concepts in design and maintenance of different system.
Reliability and Availability of Engineering systems:
Quantitative estimation of reliability of parts, Reliability of parallel and series elements, Accuracy and confidence of reliability estimation, Statistical estimation of reliability indices, Machine failure pattern, Breakdown time distribution.

Module V: Reliability improvement
Reliability in design, reliability in engineering, systems, systems with spares, reliability simulation, redundant and stand by systems, confidence levels, component improvement element, unit and standby redundancy optimization and reliability-cost trade off.
8. Fault Tree Analysis:

Introduction and importance, fault tree construction, reliability calculations from fault tree, tie set and cut set methods, event tree and numerical problems.

Text Books:

1. Lindley R. Higgins, Maintenance Engineering Handbook, McGraw Hill.
2. R.H. Clifton, Principles of Planned Maintenance, Edward Arnold.

Reference Books:

1. A Kelly, Maintenance Planning control, McGraw Hill.
2. L.S Srinath, Reliability Engineering, East West Press.
3. S.K. Sinha, Reliability Engineering, John Wiley.

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ME701P: Automation in manufacturing Laboratory

Course Objectives:	1. To provide an understanding of advanced manufacturing methods. 2. To get an idea of the dimensional & form accuracy of products.
Course Outcomes:	Upon completion of this course, students will be able to perform some advanced manufacturing operations and also be able to evaluate the accuracy & tolerance of components produced.

Detailed Contents:

About 12 experiments will be carried out as listed below.
1. Taper turning and external thread cutting using lathe
2. Contour milling using vertical milling machine
3. Spur gear cutting in milling machine
4. Measurement of cutting forces in Milling/ Turning process
5. CNC part programming
6. Drilling of a small hole using wire EDM
7. Microprocessor controlled pick & place robot
8. Use of Tool Maker's Microscope
9. Comparator and sine bar
10. Surface finish measurement equipment
11. Bore diameter measurement using micrometer and telescopic gauge
12. Use of Autocollimator

Text Books:

1 Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall
2 Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition, Pearson

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REFRENCE BOOKS:

1 Yoram Koren, Computer control of manufacturing system, 1st edition
2 Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

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ME707: Major Project

Course Objectives:	The major project may be carried out by a group of students 2 to 5. Students will learn • Initiation • Planning • Execution • Regulation • Closure
Course Outcomes:	• Students will demonstrate advanced practical knowledge among companies. • Students will be able to analyze practical work. • Student detects the problems regarding their specializing fields very easily. • The ability to understand or to capture problems by the students very practically. • Practical Knowledge skills of students better.

8TH SEMESTER

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ME801: Instrumentation and Control

Course Objectives:	• To provide a basic knowledge about measurement systems and their components • To learn about various sensors used for measurement of mechanical quantities • To learn about system stability and control
Course Outcomes:	Upon completion of this course, the students will be able to understand • the measurement of various quantities using instruments, their accuracy & range • The techniques for controlling devices automatically.

Detailed Contents:

Module I
Measurement systems and performance – accuracy, range, resolution, error sources
Static performance characteristics and Data Analysis
Static performance parameters, Errors and uncertainties in performance parameters, propagation of uncertainties in compound quantities, statistical treatment of data, curve fitting

Module II
Dynamic Characteristics of Instruments: System equations, formulation of system equations, Types of Input signals, Dynamic response of 1st order system

Module III
Instrumentation system elements – sensors for common engineering measurements; Signal Processing and conditioning; digital voltmeter, Frequency Counters, Special purpose oscilloscope, recording instruments, Telemetry and data acquisition system

Module IV
Control systems – basic elements, open/closed loop, design of block diagram; control method – P, PI, PID, when to choose what, tuning of controllers

Text Books:

1. A.K. Sawhney Mechanical Measurement & Instrumentation Dhanpat Rai & sons, New Delhi
2. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 200

Reference books:

1. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York, 1999.

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ME802: Mechanical Vibrations

Course Objectives:	• To provide a basic knowledge about vibration in mechanical systems • To learn about various methods of vibration reduction and absorption
Course Outcomes:	Upon completion of this course, students will be able to • formulate mathematical models of problems in vibrations • calculate principal modes of vibration and explore the suitable methods of vibration reduction and absorption

Detailed Contents:

Module I

Introduction, Classification of Vibration Systems, Harmonic motion, Vector representation of harmonic motion, Natural frequency & response, Effects of vibration, superposition of simple harmonic motions, beats, Fourier analysis-analytical and numerical methods. Single Degree Freedom System, Equation of motion, Newton's method, D'Alembert's principle, Energy method etc., Free vibration, Natural frequency, Equivalent systems, Displacement, Velocity and acceleration, Response to an initial disturbance, Torsional vibrations, Damped vibrations, Vibrations of systems with viscous damping, Logarithmic decrement, Energy dissipation in viscous damping.

Module II

Single Degree Freedom: Forced Vibration Forced vibration, Harmonic excitation with viscous damping, steady state vibrations, forced vibrations with rotating and reciprocating unbalance, support excitation, Vibration isolation, Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments.

Module III

Two Degree Freedom systems Introduction, Principal modes, Double pendulum, Torsional system with damping, Coupled system, Principle of vibration absorber, Undamped dynamic vibration absorbers, Torsional vibration absorber, Centrifugal pendulum absorbers, Vibration isolators and Dampers.

Module IV

Multi Degree Freedom system: Numerical Analysis by Rayleigh's method, Dunkerely's, Holzer's and Stodola methods, Rayleigh-Ritz method 5 Critical speed of shafts, Whirling of uniform shaft, Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

Text Books:

1. Mechanical Vibrations – G. K. Groover, Jain Brothers, Roorkee.
2. Mechanical Vibrations-N K Grover, PBS Publications.

Reference books:

1. Theory of Vibrations with Applications, Thomson & Dahleh, Pearson Education.
2. Elements of Vibration Analysis, L Meirovitch, McGraw-Hill Education.

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ME803: Mechatronic systems

Course Objectives:	• To understand the structure of microprocessors and their applications in mechanical devices • To understand the principle of automatic control and real time motion control systems • To understand the use of micro-sensors and their applications in various fields
Course Outcomes:	Upon completion of this course, students will get an overview of • Mechatronics applications • Micro-sensors and microprocessors.

Detailed Contents:

Module I

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modelling, Analysis and Simulation, Man-Machine Interface;

Module II

Sensors and transducers: classification, Development in Transducer technology, Optoelectronics- Shaft encoders, CD Sensors, Vision System, etc.; Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices

Module III

Review Of Basic Electronics: Ohm's law, semiconductors (PN junction diodes, AC rectification, Zener diode), Power supplies

Drive Technology- Principles and Applications: Physical principles; solenoid-type devices; DC machines; AC machines; stepper motors.

Drive Technology Applications: Linear motors; voice coil motors; electro-pneumatic and electro-hydraulic actuators.

Module IV

Elector Mechanical System- Principles and Applications: Rotary to linear motion conversion; power transmission Electromechanical System Applications, Coupling; gearing; belts; pulleys; bearings

Text Books:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education

Reference books:

1. A Textbook of Mechatronics, R.K.Rajput, S. Chand & Company Private Limited
2. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

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ME804: Finite Element Analysis

Course Objectives:	1. To illustrate the principle of mathematical modelling of engineering problems 2. To introduce the basics and application of Finite Element Method
Course Outcomes:	Upon completion of the course, students will understand the FEM formulation and its application to simple structural and thermal problems

Detailed Contents:

Module I
Historical Background, Mathematical modelling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.

Module II
One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

Module III
Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

Module IV
Natural coordinate systems, isoperimetric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software.

Text Books:

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007

Reference books:

1. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann,2004
2. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice

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ME805: Fundamentals of Management for Engineers

Course Objectives:	To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers. • To help the students gain understanding of the functions and responsibilities of industrial managements. • To enable them to analyze and understand the environment of the organization
Course Outcomes:	The students understand the significance of Management in their Profession. • The various Management Functions like Planning, Organizing, Staffing, Leading, aspects are learnt in this course. • Demonstrate the roles, skills and functions of management.

Detailed Contents:

Module I

Introduction to Management: Definition, Nature and Scope, Functions of Management, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management. Introduction to Operations Management, Types of Plant Layout, Introduction to Total Quality Management (TQM), Total Quality Management Models, Benefits of TQM, Basics of Six Sigma and Lean Manufacturing.

Module II

Introduction to Marketing, Functions of Marketing, Types of Marketing, Marketing vs. Selling, Marketing Mix, Product Life Cycle, Market Segmentation, Supply Chain Management (SCM).

Module III

Introduction to Work Analysis, Definition, need and scope of work analysis, Method Study: Objectives, Step-by-step procedure, Charts and diagrams for recording data, Principles of Motion economy, Therbligs, Work Measurement: Definition, Various techniques of work measurement such as Work Sampling, Stop Watch Time Study, Analytical Estimating, Predetermined Motion Time System, Need for operator rating, Methods of rating, Allowances and their types

Module IV

Introduction to Productivity: Definition, Reasons for low productivity, methods to improve productivity, Value Engineering: Definition, Types of values, concept, phases and applications of value engineering

Module V

Introduction to Personnel Management, aims and objectives of personnel management, Principles of a good personnel policy, Recruitment and selection of employees, Education and training of employees, Safety engineering.

Text Books:

1. Industrial Engineering and Management/ O. P. Khanna / Dhanpat Rai and Sons
2. A Text Book of Industrial Management/ A. P. Verma and N. Mohan/ Katson

Reference books:

1. Management Essentials/ Andrew Dubrin / Cengage Learning
2. Fundamentals of Management/ Stephen P. Robbins/ Pearson Education

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ME806: Product Design and Development

Course Objectives:	To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers. • To help the students gain understanding of the functions and responsibilities of industrial managements. • To enable them to analyze and understand the environment of the organization.
Course Outcomes:	The students understand the significance of Management in their Profession. • The various Management Functions like Planning, Organizing, Staffing, Leading, aspects are learnt in this course. • Understand the complexities associated with management in the organizations and integrate the learning in handling these complexities.

Detailed Contents:

Module I

Introduction to Product Design: Design by Evolution and Innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in Production consumption cycle, The Morphology of Design, Primary design phases and flowcharting, Role of Allowances, process capability and tolerances in detailed design and assembly

Module II

Product Design and Industry: Product Strategies, Time to Market, Analysis of the Product, Standardization, Simplification and specialization, Basic design considerations, Role of Aesthetics in product design, Functional design practice

Module III

Design for Production: Producibility requirements in the design of machine components, Forging design, Pressed component design, Casting design for economical molding, eliminating defects and features to aid handling, Design for machining ease, the role of process Engineer, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts

Module IV

Economic Factors Influencing Design: Product value, Design for safety, reliability and Environmental considerations, Manufacturing operations in relation to design, Economic analysis, profit and competitiveness, break even analysis,

Module V

Modern Approaches to product Design: Concurrent Design, Quality Function Deployment (QFD)
Rapid Prototyping: Principle of Rapid Prototyping, Rapid Prototyping Technologies (RPT), RPT in Industrial Design.

Text Books:

1. Product Design and Development by Kail T Ulrich and Steven D Eppinger
2. Product Design and Development by AK Chitale and Gupta

Reference books:

1. Design of Systems and Devices by Middendorf Marcel Dekker

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ME-807: Six Week Internship

Course Objective	• This course is aimed to provide more weightage for project work. • The project work could be done in the form of project during 6 week internship in the industry • Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.
Course Outcomes	• Students will demonstrate advanced practical knowledge among companies. • Students will be able to analyze practical work. • Student detects the problems regarding their specializing fields very easily. • The ability to understand or to capture problems by the students very practically.