BTech (Mechanical Engineering)

Curriculum :: Category-wise distribution of courses

	Category	Course Detail								Category-wise credits
		SN	Code	Title	L	T	P	Cr	CH	
I	Humanities and Social Science including Management courses (HSMC)	1	EF103	English	2	0	1	3	4	12
		2	BA201	Economics	3	0	0	3	3	
		3	IC361	Accounting and Finance Management	3	0	0	3	3	
		4	XXxxx	HSS/Management Elective	3	0	0	3	3	
II	Basic Science Courses (BSC)	1	CH103	Chemistry	3	0	1	4	5	23
		2	MS104	Mathematics I	3	1	0	4	4	
		3	PH103	Physics I	2	0	1	3	4	
		4	PH104	Physics II	2	0	0	2	2	
		5	MS105	Mathematics II	3	1	0	4	4	
		6	MS205	Mathematics III	3	0	0	3	3	
		7	BT201	Biology	3	0	0	3	3	
III	Engineering Science Courses (ESC)	1	EE103	Basic Electrical Engineering	3	0	0	3	3	25
		2	EE104	Basic Electrical Engineering Lab	0	0	1	1	2	
		3	EC102	Basic Electronics	2	1	1	4	5	
		4	ME102	Engineering Mechanics	3	1	0	4	4	
		5	ME103	Workshop Practice	0	0	2	2	4	
		6	CO103	Introductory Computing	3	0	0	3	3	
		7	CO104	Computing Laboratory	0	0	2	2	4	
		8	CE103	Engineering Graphics	1	0	2	3	5	
		9	ME203	Material Science	3	0	0	3	3	
IV	Professional Core Courses (PCC)	1	ME201	Solid Mechanics	3	1	0	4	4	55
		2	ME202	Fluid Mechanics I	2	1	0	3	3	
		3	ME205	Thermodynamics	3	1	0	4	4	
		4	ME208	Manufacturing Technology I	3	0	0	3	3	
		5	ME209	Fluid Mechanics II	2	1	0	3	3	
		6	ME214	Kinematics of Machinery	2	1	0	3	3	
		7	ME215	Mechanical Measurements and Instrumentation	3	0	0	3	3	
		8	ME216	Manufacturing Technology II	3	0	0	3	3	
		9	ME217	ME Lab (Design) I	0	0	2	2	4	
		10	ME308	Heat and Mass Transfer	3	1	0	4	4	
		11	ME311	Machine Design I	2	1	0	3	3	
		12	ME312	Machine Design II	3	0	0	3	3	
		13	ME313	Dynamics of Machinery	3	0	0	3	3	
		14	ME314	Applied Thermodynamics	3	1	0	4	4	
		15	ME315	ME Lab (Manufacturing) II	0	0	2	2	4	
		16	ME316	Computer-Aided Engineering	1	0	2	3	5	
		17	ME317	ME Lab (Thermal) III	0	0	2	2	4	
		18	ME401	Industrial Systems Engineering	3	0	0	3	3	
V	Professional Elective Courses (PEC)	1		ME Elective I	3	0	0	3	3	18
		2		ME Elective II	3	0	0	3	3	
		3		ME Elective III	3	0	0	3	3	
		4		ME Elective IV	3	0	0	3	3	
		5		ME Elective V	3	0	0	3	3	
		6		ME Elective VI	3	0	0	3	3	
VI	Open Elective Courses (OEC)	1		Open Elective I	3	0	0	3	3	12
		2		Open Elective II	3	0	0	3	3	
		3		Open Elective III	3	0	0	3	3	
		4		Open Elective IV	3	0	0	3	3	
VII	Project, Seminar and Internship in Industry or elsewhere (Pr)	1	ME318	Mini Project	0	0	2	2	4	16
		2	ME471	Industrial Summer Training	-	-	-	2	-	
		3	ME483	Project I	0	0	4	4	8	
		4	ME484	Project II	0	0	8	8	16	
VIII	Mandatory-Non-Credit Courses (NCr)	Induction Program ,Environmental Science, , Indian Constitution, and Essence of Indian Traditional Knowledge			-	-	-		13	-
Total					**114**	**12**	**33**	**161**	**205**	**161**

BTech (Mechanical Engineering)

Curriculum :: Semester-wise distribution of courses

Sem	Course detail								Total credits in the semester
	SN	Code	Title	L	T	P	Cr	CH	
I	1	CH103	Chemistry	3	0	1	4	5	18
	2	MS104	Mathematics I	3	1	0	4	4	
	3	PH103	Physics I	2	0	1	3	4	
	4	EE103	Basic Electrical Engineering	3	0	0	3	3	
	5	EE104	Basic Electrical Engineering Lab	0	0	1	1	2	
	6	EF103	English	2	0	1	3	4	
	7	SE100	Induction Program	-	-	-	-	8	
II	1	PH104	Physics II	2	0	0	2	2	24
	2	MS105	Mathematics II	3	1	0	4	4	
	3	EC102	Basic Electronics	2	1	1	4	5	
	4	ME102	Engineering Mechanics	3	1	0	4	4	
	5	ME103	Workshop Practice	0	0	2	2	4	
	6	CO103	Introductory Computing	3	0	0	3	3	
	7	CO104	Computing Laboratory	0	0	2	2	4	
	8	CE103	Engineering Graphics	1	0	2	3	5	
III	1	MS205	Mathematics III	3	0	0	3	3	21
	2	BA201	Economics	3	0	0	3	3	
	3	ME201	Solid Mechanics	3	1	0	4	4	
	4	ME202	Fluid Mechanics I	2	1	0	3	3	
	5	ME203	Material Science	3	0	0	3	3	
	6	ME208	Manufacturing Technology I	3	0	0	3	3	
	7	ME217	ME Lab (Design) I	0	0	2	2	4	
	8	ES201*	Environmental Science	1	0	1	0	3	
IV	1	BT201	Biology	3	0	0	3	3	19
	2	ME205	Thermodynamics	3	1	0	4	4	
	3	ME209	Fluid Mechanics II	2	1	0	3	3	
	4	ME214	Kinematics of Machinery	2	1	0	3	3	
	5	ME215	Mechanical Measurements and Instrumentation	3	0	0	3	3	
	6	ME216	Manufacturing Technology II	3	0	0	3	3	
V	1	ME308	Heat and Mass Transfer	3	1	0	4	4	22
	2	ME311	Machine Design I	2	1	0	3	3	
	3	ME313	Dynamics of Machinery	3	0	0	3	3	
	4	ME314	Applied Thermodynamics	3	1	0	4	4	
	5	ME315	ME Lab (Manufacturing) II	0	0	2	2	4	
	6		ME-Elective I	3	0	0	3	3	
	7		Open Elective I	3	0	0	3	3	
	8	LW301*	Indian Constitution	1	0	0	0	1	
VI	1	IC361	Accounting and Finance Management	3	0	0	3	3	22
	2	ME312	Machine Design II	3	0	0	3	3	
	3	ME316	Computer-Aided Engineering	1	0	2	3	5	
	4	ME317	ME Lab (Thermal) III	0	0	2	2	4	
	5	ME318	Mini Project	0	0	2	2	4	
	6		ME-Elective II	3	0	0	3	3	
	7		ME Elective III	3	0	0	3	3	
	8		Open Elective II	3	0	0	3	3	
VII	1	XXxxx	HSS/Management Elective	3	0	0	3	3	21
	2	ME401	Industrial Systems Engineering	3	0	0	3	3	
	3	ME471**	Industrial Summer Training #	-	-	-	2	0	
	4	ME483	Project I	0	0	4	4	8	
	5		ME Elective IV	3	0	0	3	3	
	6		ME Elective V	3	0	0	3	3	
	7		Open Elective III	3	0	0	3	3	
	8	CT465*	Essence of Indian Traditional Knowledge	1	0	0	0	1	
	# Industrial Summer Training: Training shall be of 8 weeks duration carried out during the summer break after the 6th semester. The report will be submitted in the 7th semester.								
VIII	1		ME Elective VI	3	0	0	3	3	14
	2		Open Elective IV	3	0	0	3	3	
	3	ME484	Project II	0	0	8	8	16	
Total				**114**	**12**	**33**	**161**	**205**	**161**

*__ES201, LW301 and CT465__ are Mandatory-Non-Credit courses as per the revised-AICTE guidelines. The lectures and laboratory classes assigned for these courses are not considered in the calculation of total credit structure. However, these courses are considered while calculating the number of hours.

**The credit-break up for ME471 (Industrial Summer Training) is not shown in the table. However, its contribution of 2 credits is considered while calculating the total credit of 161 for the curriculum.

Detailed syllabus

Semester I

CH103	**Chemistry**	**L-T-P-Cr-CH: 3-0-1-4-5**	**Prerequisites: None**

DETAILS OF THE SYLLABUS
Theory:

(i) Atomic and molecular structure (11 lectures)

Schrödinger 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 multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. 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.

(ii) Spectroscopic techniques and applications (6 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.

(iii) 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 H_3, H_2F and HCN and trajectories on these surfaces.

(iv) Use of free energy in chemical equilibria (5 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.

(v) Nuclear Chemistry (4 Lectures)

Isotopes, isotones, isobars, α, β and γ rays, nuclear transformations, fission and fusion, cosmic rays, binding energy, packing fraction, radioactive hazards, nuclear power plants.

(vi) 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

(vii) 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.

Books:

1) University chemistry, by B. H. Mahan
2) Chemistry: Principles and Applications, byM. J. Sienko andR. A. Plane
3) Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
5) Physical Chemistry, by P. W. Atkins
6) Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

MS104	Mathematics I	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: None

Unit 1: Sequence and series ***(8 lectures)***

Sequence and series of real numbers, tests for convergence. Power series, Taylor's series, series for exponential, trigonometric and logarithm functions.

Unit 2: Calculus ***(6 lectures)***

Continuity and differentiability of single variable, Rolle's theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders, Indeterminate forms, L'Hospital's rule.

Unit 3: Multivariable calculus ***(8 lectures)***

Limit, continuity and differentiability of functions of several variables, partial derivatives, directional derivatives, total derivative. Euler's theorem on homogeneous functions. Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Unit 4: Multiple integrals ***(10 lectures)***

Gradient, Curl, Divergence, Laplacian, line integral, multiple integral, change of order of integration and change of variables, surface integral, theorems of Green. Gauss and Stokes theorems, orthogonal curvilinear coordinates. Simple applications involving cubes, sphere and rectangular parallelepipeds.

Unit 5: Improper integrals ***(5 lectures)***

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.

Unit 6: Ordinary differential equations ***(8 lectures)***

First order differential equations – exact, linear and Bernoulli's form, second order differential equations with constant coefficients, Euler equations. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equations.

Textbook(s)

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, (John Wiley & Sons, Ninth Edition), 2006.
2. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition), 1998.

Reference book(s)

1. Jain, R. K. and Iyengar, S. R. K. *Advanced Engineering Mathematics*, (Narosa publishing house, India, Third Edition), 2009.
2. Veerarajan T., *Engineering Mathematics for first year*, (Tata McGraw-Hill, New Delhi), 2008.
3. Ramana, B. V. *Higher Engineering Mathematics*, (McGraw Hill, India), 2010.
4. Ross S. L., *Differential Equations*, (Wiley India, Third edition), 1984.

PH103	Physics-I	L-T-P-Cr-CH: 2-0-1-3-4	Prerequisites: None

Module 1: Mechanics 10 hours

Transformation of scalars and vectors under Rotation transformation; Newton's laws; curvilinear coordinate systems; Concepts of potential energy, conservative and non-conservative forces; Angular momentum and orbital motion; Non-inertial frames of reference; Rotating coordinate system, Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum; Rigid body motion and its application;

Module 3: Optics 7 hours

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave.
Mirrors and lenses and optical instruments based on them, Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer, Mach-Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

Module 5: Electromagnetic Theory 9 hours

Basics to electrostatics and magnetostatics; Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations: Continuity equation for current densities; Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field;
Flow of energy and Poynting vector with examples. The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Total 26 hours

References

(i) Fundamentals of Physics, Halliday and Resnick
(ii) Electricity, magnetism and light, W. Saslow
(iii) Engineering Mechanics - Dynamics, JL Meriam
(iv) An Introduction to Mechanics, D Kleppner & R Kolenkow
(v) Introduction to Electrodynamics, David Griffiths

EE 103	Basic Electrical Engineering	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Detailed contents :

Module 1 : DC Circuits (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with de excitation. Superposition. Thevenin and Norton Theorems. 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, real power, reactive power, apparent power, power factor. Analysis of single-phase ac cireuits consisting of R, L, C. RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours)

Magnetic materials and magnetic circuits, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three- phase transformer connections.

Module 4: Electrical Machines (8 hours)

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 de motor. Construction and working of synchronous generators.

Module 5: Introduction to Semiconductor Devices (6 hours)

Semiconductor materials. Concept of energy band diagram and doping. Diode, special diodes, clipping and clamping circuits, rectifier circuits using diode, principle and working of BJT, MOSFET, Basic digital electronics concept.

Module 6: Electrical Installations (6 hours)

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

Suggested Text / Reference Books

(i) D. P. Kothari and |. J. Nagrath, “Basic Electrical Engineering”. Tata McGraw Hill. 2010.

(ii) D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.

(iii)L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011. (iv) E. Hughes, “Electrical and Electronics Technology™, Pearson, 2010.

(v) V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes

CO1: To understand and analyze basic electric and magnetic circuits
CO2: To study the working principles of electrical machines and semiconductor devices. To introduce the components of low voltage electrical installations.

EE 104	**Basic Electrical Engineering Laboratory**	**L-T-P-Cr-CH: 0-0-1-1-2**	**Prerequisites: None**

List of Laboratory Experiments/Demonstrations:

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 storage oscilloscope).

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. Transformers: Observation of the no-load current waveform on an oscilloscope (nonsinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.

4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line- line voltage, phase-to-neutral voltage, line and phase currents).

Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.

5. Demonstration of cut-out sections of machines: de machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.

6. Torque Speed Characteristic of separately excited de motor.
7. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor.

Generator operation of an induction machine driven at super-synchronous speed.

8. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.

9. Demonstration of characteristic of different diode. Input output characteristic of BJT, MOSFET. Basic structure of clipping clamping circuit.

Course Outcomes

CO1: To familiarize with the basic electrical/electronic equipment/component and its working with its operation characteristic.

CO2: To develop an ability to identify, formulate and solve problems related to basic Electrical Engineering.

To develop an ability to design, perform, analyze and interpret experiment/ experimental result on Network/Circuit Theory/ Electrical Machines/BJT/MOSFET.

EF103	**English**	**L-T-P-Cr-CH: 2-0-1-3-4**	**Prerequisites: None**

Pre-requisites (if any)

- Basic knowledge of English grammar, rules of writing and speaking in English.

Detailed Course content and activities

A. Vocabulary and grammar

Discussion on the following before and/or after the activities mentioned in B, C and D

- Structure of simple sentences;
- Agreement of verb and subject;
- Use of adverbials; Tenses,
- Use of passive in scientific discourse, various types of questions,
- Direct and indirect narration,
- Articles,
- Prepositions**,**
- English modal verbs,
- Errors in the use of individual words

B. Reading

- Reading and comprehension: global and local comprehension, drawing inferences

- **Materials: Stories and essays** (preferably a collection of comparatively short essays on scientific, interestingly written topics, short stories- adventure and scientific fiction)

- Reading silently in class followed by short comprehension questions, brief writing exercises, summaries in brief, personal responses (not typical question-answer type)- both oral and written. Reading material from Internet and talking and writing about them; reading scientific reports, articles collected from newspapers and magazines, Internet etc. and writing notes etc on them.

C. Writing

- Preparing project proposal and reports
- Writing applications of various types and for various purposes
- Curriculum vitae/Resume
- Letters to the editors, letters to various agencies.
- Essay and Précis,
- Notice both formal and informal/friendly,
- Memo/ notes

D. Speaking: Oral Communicative Activities

- Listening Comprehension: Information transfer activities: Pair and group works involving transfer of information: Gleaning information from different types of written materials including articles etc. and talking about them
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations: Use of Graphic presentation, Presentation aids
- Formal group discussion
- Formal Speech

Course Outcomes

The students will

CO1: Acquire proficiency in English enabling them to use English for communication and for study purposes;

CO2: Develop their interactive/speaking skills by developing their ability to listen to English for formal, as in class lectures and informal, as in face to face interactive, situations) with a high degree of understanding, and help them to speak English with a reasonable degree of fluency and with an acceptable pronunciation of the sounds of English;

CO3: Develop the basic skill for academic as well as non-academic writing.

Reference Books:

1. Sharma, S. and B. Mishra (2009).*Communication Skills for Engineers and Scientists.* PHI, New Delhi.
2. Wood, F. T. (2010) *A Remedial English Grammar for Foreign Students*. Macmillan, Delhi.
3. Greenbaum, Sidney.(2005).*Oxford English Grammar*. Oxford University Press, New Delhi, Indian Edition.
4. Kenneth, Anderson, Tony Lynch, and Joan Mac Lean. (2008). *Study Speaking*. CUP, New Delhi.
5. Lynch, Tony. (2008). *Study Listening*. CUP, New Delhi.
6. Thomson and Martinet. (2008).*A Practical English Grammar.* Oxford ELBS, Delhi.
7. Swan, Michael. *Practical English Usage*. OUP, New Delhi . 1995
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Semester II

PH104	**Physics-II**	**L-T-P-Cr-CH:2-0-0-2-2**	**Prerequisites: None**

Module 4: Quantum Mechanics 11 hours

Wave nature of particles and the Schrodinger equation; Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle; Application of Schrodinger equation: particle in a box, particle in attractive delta-function potential, square-well potential, linear harmonic oscillator; Three-dimensional problems: particle in three dimensional box and related examples, Angular momentum operator, Rigid Rotor, Hydrogen atom ground-state, orbitals, interaction with magnetic field, spin.

Module 2: Waves and oscillations 7 hours

Simple harmonic motion, damped and forced simple harmonic oscillator, quality factor, Applications in mechanical and electrical systems, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator; Non-dispersive transverse and longitudinal waves in one dimension and introduction to dispersion; superposition of waves and Fourier method, wave groups and group velocity;

Module 6: Solid state, semiconductor physics and Lasers 12 hours

Free electron theory of metals, Fermi level, density of states, Application to white dwarfs and neutron stars, Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands; Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices. Semiconductor light emitting diodes (LEDs): Rate equations for carrier density, Radiative and non-radiative recombination mechanisms in semiconductors, LED: device structure, materials, characteristics, and figures of merit; Semiconductor lasers: Review of laser physics; Rate equations for carrier- and photon-density, and their steady state solutions, Laser dynamics, Relaxation oscillations, Input-output characteristics of lasers. Semiconductor laser: structure, materials, device characteristics, and figures of merit; Types of semiconductor photodetectors, working principle, and characteristics; Solar cells, Solid state lasers, He-Ne lasers.

Total **30 hours**

References

(i) Introduction to solid state physics- Kittle
(ii) Quantum mechanics, D. J. Griffiths
(iii) Oscillations and waves in physics, Ian G. Main
(iv) The physics of vibrations and waves, H.J. Pain
(v) Online course: "Semiconductor Optoelectronics" by M R Shenoy on NPTEL
(vi) Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL
(vii) Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL

MS105	**Mathematics II**	**L-T-P-Cr-CH: 3-1-0-4-4**	**Prerequisites: None**

Unit 1: Linear algebra ***(12 lectures)***

Rank of a matrix, determinants, Cramer's Rule. Linear systems of equations, Direct methods: Gauss elimination, Gauss-Jordan elimination and LU factorization.

Vector spaces – Linear dependence of vectors, basis, linear transformations, range and kernel of a linear map, rank and nullity, rank-nullity theorem. Matrix associated with a linear map. Eigenvalues and eigenvectors, Cayley-Hamilton Theorem.

Unit 2: Complex analysis ***(6 lectures)***

Limit, continuity, differentiability and analyticity of functions Cauchy-Riemann equations, elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

Unit 3: Complex integration ***(8 lectures)***

Line integrals, contour integral, Cauchy's integral theorem, Cauchy's integral formula, 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).

Unit 4: Numerical methods-I ***(7 lectures)***

Finite differences, relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae.
Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson Method, Secant method and Regula-Falsi method.

Unit 5: Numerical methods-II ***(6 lectures)***

Taylor's series, Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's rules. Numerical solution of ordinary differential equations using Euler and modified Euler's methods. Runge-Kutta methods.

Unit 6: Integral transform ***(6 lectures)***

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.
Fourier series, Fourier transforms. methods, inverses and their applications.

Textbook(s)

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, (John Wiley & Sons, 9th Edition), 2006.
2. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition), 1998.

Reference book(s)

1. Jain, R. K. and Iyengar, S. R. K. *Advanced Engineering Mathematics*, Third Edition, (Narosa publishing house, India), 2009.
2. Veerarajan T., *Engineering Mathematics for first year*, (Tata McGraw-Hill, New Delhi), 2008.
3. Ramana, B. V. *Higher Engineering Mathematics*, (McGraw Hill, India), 2010.
4. Brown J. W. and Churchill R. V., *Complex Variables and Applications*, (Mc-Graw Hill, 7th Edition), 2004.

EC102	Basic Electronics	L-T-P-Cr-CH: 2-1-1-4-5	Prerequisites: None

Module 1: Diodes and Applications(10 hours):
Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, 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; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications

Module 2: Transistor Characteristics (10 hours):
Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration; Field Effect Transistor (FET) – Construction, Characteristics of Junction FET, Depletion and Enhancement type Metal Oxide Semiconductor (MOS) FETs, Introduction to CMOS circuits

Module 3: Transistor Amplifiers and Oscillators (7 hours):
Classification, Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC Equivalent Circuit; Feedback Amplifiers – Principle, Advantages of Negative Feedback, Topologies, Current Series and Voltage Series Feedback Amplifiers; Oscillators – Classification, RC Phase Shift, Wien Bridge, High Frequency LC and Non-Sinusoidal type Oscillators;

Module 4: Operational Amplifiers and Applications (5 hours):
Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal OpAmp, Concept of Virtual Ground;

Module 5: Digital Systems (10 hours):
Number Systems and Codes, r's Complements and (r-1)'s Complements, Binary Addition and Subtraction, Representation of Negative Number, Floating Point Representation. Logic Gates: Basic and Universal, Boolean Theorems, De' Morgan's theorems, Sum-of-Products form, Algebraic Simplification, Karnaugh Map, Basic Combinational Circuit Concept : Half Adder, Full Adder, Sequential circuit concept : Basic Flip-Flops (RS, D, JK Flip-Flop).

Basic Electronics Laboratory:
List of experiments/demonstrations:

- Laboratory Sessions covering, Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and DIP), Bread Boards and Printed Circuit Boards (PCBs); Identification, Specifications, Testing of Active Devices – Diodes, BJTs, JFETs, MOSFETs, Power Transistors, SCRs and LEDs

- Study and Operation of Digital Multi Meter, Function / Signal Generator, Regulated Power Supply (RPS), Cathode Ray Oscilloscopes; Amplitude, Phase and Frequency of Sinusoidal Signals using Lissajous Patterns on CRO; (CRO)

- Experimental Verification of PN Junction Diode Characteristics in A) Forward Bias B) Reverse Bias, Zener Diode Characteristics and Zener Diode as Voltage Regulator, Input and Output Characteristics of BJT in Common Emitter (CE) Configuration, Drain and Transfer Characteristics of JFET in Common Source (CS) Configuration
- Study of Half Wave and Full Wave Rectification, Regulation with Filters, Gain and Bandwidth of BJT Common Emitter (CE) Amplifier, Gain and Bandwidth of JFET Common Source (CS) Amplifier, Gain and Bandwidth of BJT Current Series and Voltage Series Feedback Amplifiers, Oscillation Frequency of BJT based RC Phase Shift, Hartley and Colpitts Oscillators; Module 5: Op-Amp Applications – Adder, Subtractor, Voltage Follower and Comparator; Op-Amp Applications – Differentiator and Integrator, Square Wave and Triangular Wave Generation, Applications of 555 Timer – Astable and Monostable Multivibrators

- Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs); Truth Tables and Functionality of Flip-Flops – SR, JK and D Flip-Flop ICs; Serial-In-Serial-Out and Serial-In-Parallel-Out Shift operations using 4-bit/8-bit Shift Register ICs; Functionality of Up-Down / Decade Counter ICs

Text/Reference Books:

1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India
2. Santiram Kal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India
3. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education,
4. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH
5. R. T. Paynter (2009), Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson
6.R.L. Boylestad and L.Nashelsky : Electronic Devices and Circuit Theory; PHI, 6e, 2001.
7. A.P. Malvino : Electronic Principles; New Delhi, Tata McGraw-Hill, 1993
8. R.A. Gayakward, "OpAmps and Linear Integrated Circuits, New Delhi : PHI, 2002.

ME102	Engineering Mechanics	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: None

Objectives:

i. Applying their knowledge of 12th level Mathematics and Physics to solve practical engineering problems dealing with mechanics.
ii. Identify the basic principles that govern the dynamics of particles and rigid bodies.
iii. Develop ideas on various conditions on loading and support conditions that act on a structural system.
iv. Extend their knowledge to take on higher level courses in Solid Mechanics, Theory of Machines and Structural Analysis.
v. Impart competence to the students for solving problems of the standards pertaining to standards of the various national level competitive examinations like GATE, UPSC, PSUs etc.

Contents:

Force systems: Force, moment of a force about a point and about an axis, couple moment as a free vector, equivalent force systems **(7L + 1T)**

Equilibrium: Free body diagram, equations of equilibrium; problems in two and three dimensions, **(4L + 1T)**

Structural Mechanics: Simple truss, method of joints, method of sections, frames and simple machines **(4L + 1T)**

Friction: Laws of coulomb friction, angle of friction, applications to wedge, belt-pulley, power screw, journal bearing, brakes and clutches **(3L + 1T)**

Distributed Force System: Centre of mass, centre of gravity, moment of inertia of an area, product of inertia of an area, mass moment of inertia, product of inertia of a mass **(8L+ 2T)**

Energy Methods: Principle of virtual work, principle of minimum potential energy **(3L + 1T)**

Kinematics and Kinetics of particles: Particle dynamics in rectangular coordinates and in terms of path variables; Newton's law for rectangular coordinates, Newton's law for path variables, central force motion **(4L + 1T)**

Energy and Momentum Methods for Particle: Conservative force field, principle of work and energy, principle of impulse and momentum, impact. **(3L+ 1T)**

Kinematics and Kinetics of rigid body: Translation and rotation of rigid body, motion relative to rotating axes, Coriolis acceleration, equations of motion for a rigid body **(3L + 1T)**

(Total: 37 lectures + 12 tutorials)

Course Outcomes:

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

CO1: Solve fundamental problems related to forces being applied to a body under static and dynamic conditions.

CO2: Evaluate the kinetic and kinematic parameters of particles in motion.

CO3: Apply the governing principles of properties of areas in determining centroid and moment of inertia of different sections.

CO4: Identify and model various types of loading and support conditions that act on structural systems.

CO5: Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.

CO6: Evaluate the motion of a particle in terms of its position, velocity and acceleration in different frames of reference and to analyze the forces causing the motion of a particle.

Textbooks:

1. Beer, F.P., Johnston, E.R., Mazurek, D.F., Cornwell, P.J., Eisenberg, and E.R., Sanghi, S. *Vector Mechanics for Engineers: Statics and Dynamics*. Tata McGraw Hill, 9th edition, 2011.
2. Shames, I.H. and Krishna Mohana Rao, G. *Engineering Mechanics: Statics and Dynamics*. Pearson Education Prentice Hall India, 4th edition, 2011.

Reference:

1. Meriam, J. L., and Kraige, L.G. *Engineering mechanics: Statics, Vol. 1.* John Wiley & Sons, 7th edition, 2012.
2. Meriam, James L., and Kraige, L.G. *Engineering mechanics: Dynamics. Vol. 2*. John Wiley & Sons, 7th edition, 2012.
3. Timoshenko, S., Young, D.H. and Rao J.V., *Engineering Mechanics*. Tata McGraw Hill, New Delhi, 5th edition, 2010.
4. Hibbler, R.C. *Engineering Mechanics: Statics and Dynamics*. McMillan, 3rd edition, 2012.
5. Kumar, K.L. *Engineering Mechanics*. Tata McGraw Hill, New Delhi, 4th edition, 2010.

ME103	Workshop Practice	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: Nil

Objectives:

i. To familiarize students with the various types of machines and an understanding different machining operations.
ii. To provide an understanding the physical significations and use of welding and fitting in manufacturing process.
iii. To provide an understanding on different electrical hand tools, machine tools and circuits and introduce them to different type of jobs (such as House Wiring, Switch Board etc.).

Machining: Introducing to various machine tools and demonstration on various machining process. Making jobs as per drawings; **(7P)**

Fitting Practices: Study of different vices, power hammer. Making jobs as per drawing; **(6P)**
Welding Practice: Introduction to different welding processes. Practice on Oxy-acetylene gas welding and manual metal arc welding; **(6P)**

Wireman: Introduction to different electrical hand tools and machine tools and demonstration on basic electrical components and circuits, making jobs (such as House Wiring, Switch Board etc.) as per drawing. **(7P)**

(Total: 26 Practicals)

Course Outcomes:

CO1: On the successful completion of the course, the student would be able to:
CO2: Perform machining operations using various manufacturing techniques.
CO3: Perform fitting practices using various types of hand tool and fitting techniques.
CO4: Perform Oxy-acetylene gas welding and manual metal arc welding on jobs.
CO5: Select appropriate electrical hand tools and circuits for the required application and making jobs (such as House Wiring, Switch Board etc.) as per specification.

Textbooks

1. Chapman, W. A. J. *Workshop Technology Part 1*. CBS Publishers & Distributors, 5th edition, 2001.
2. Chapman, W. A. J. *Workshop Technology Part 2*. CBS Publishers & Distributors, 4th edition, 2005.

References

1. Thereja, B. L. and Thereja, A. K. *A Textbook of Electrical Technology Vol 1*. S. Chand, 22rd edition, 1999.
2. Raghuwanshi, B. S. *Workshop Technology Vol. 1*. Dhanpat Rai and Sons, 2014.
3. Raghuwanshi, B. S. *Workshop Technology Vol. II*. Dhanpat Rai and Sons, 11th edition, 2013.
4. Amstead, B. H., Ostwald, P. F. and Begeman, M. L. *Manufacturing Process*. Wiley, 8th Edition, 1987.

CO 103	Introductory Computing	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Abstract: This course focuses on the development of programming and problem solving skills of the students. The course begins with familiarizing the students about the fundamentals of computer system. Itemphasizes how real problems can be analyzed, outlined and finally transformed into a well-organized program.

Computer Fundamentals:

- History, Generations, Classification of Computers;
- Software and hardware
- Organization of a Computer: Input/Output devices, Memory, CPU;
- Levels of computer languages.
- Character and number representations in computer.

Introduction to Programming:

- Concept of Algorithm, Flow Chart, Pseudocode, Illustrative Problem Solving Examples.
- Features of a Programming Language: Character Set, Identifiers, Keywords, Data Types, Variables, Declarations.
- Operators & Expressions: Types of operators, precedence and associativity rules;
- Statements: Assignment, formatted and unformatted Input/Output;
- Flow Control- Conditionals and Branching, Iteration;
- Functions: Defining and accessing function, function prototypes, Recursion, Scope rules;
- Data types: Derived and user defined data types (arrays, string, pointers, structures etc.)

(A programming language like C/C++ shall be used as a basis language. The same language is to be used for the laboratory).

Books:

1. Fundamentals of Computers, Rajaram, V.
2. Programming in C, Balaguruswamy.
3. Programming in C, Gottfreid, McGrawHill

Reference:

1. Let us C, Kanetkar Y.
2. Theory and Problems of Computers and Programming, Schied, F. S.
3. The C Programming Language, Kerningham& Ritchie.

Outcomes:

CO1: Students are able to develop algorithms and write programs related to simple and moderate real problems using a programming language.

CO2: Students attain confidence and capability of problem solving using computer.

CO 104	Computing Laboratory	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: None

Laboratory exercises shall involve the following:

1. Familiarization of a computer and the environment and execution of sample programs
2. Expression evaluation
3.Conditionals and branching
4.Iteration
5.Functions
6.Recursion
7.Arrays
8.Structures
9.Pointers

Books:

1. Programming in C, Balaguruswamy.
2. Programming in C, Gotfreid, McGrawHill

References:

1. Let us C, Kanetkar Y.
2. Understanding pointers in C, Kanetkar Y.

CE103	Engineering Graphics	L-T-P-Cr-CH: 1-0-2-3-5	Prerequisites: None

Introduction to IS code of drawing; Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute; projection of lines – traces, true length; projection of planes and solids; sold objects – cube, prism, pyramid, cylinder, cone and sphere; projection on Auxiliary planes; Isometric projection, isometric scale; section of solids – true shape of section; Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

Text Books

1. N D Bhatt, *Elementary Engineering Drawing,* Charotar Book Stall, Anand
2. V Lakshminarayanan, *Engineering Graphics,* R S VaishWanar, Jain Brithers, New Delhi

References

1. A M Chandra, S Chandra, *Engineering Graphics*, Narosa
2. P. J. Shah, *Engineering Graphics,* S. Chand

Semester III

MS205	Mathematics III	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Unit 1: Basic Probability ***(10 lectures)***

Probability spaces, conditional probability, Discrete random variables, Independent random variables, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, infinite sequences of Bernoulli trials, Probability distributions: Binomial, Poisson - evaluation of statistical parameters for these distributions, Poisson approximation to the binomial distribution.

Unit 2: Continuous Probability Distributions ***(5 lectures)***

Continuous random variables and their properties, distribution functions and densities, normal, exponential, and gamma densities.

Unit 3: Applied Statistics ***(11 lectures)***

Moments, Skewness, Kurtosis, Chebyshev's Inequality, Correlation and regression, method of least squares. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Unit 4: Curve fitting ***(4 lectures)***

Curve fitting - fitting of straight lines, second degree parabolas and more general curves. Splines fitting.

Unit 5: Partial differential equations ***(15 lectures)***

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear and non-linear PDEs. Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular integral method. Second-order linear equations and their classification. Method of separation of variables.

Textbook(s)

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, (John Wiley & Sons, 9th Edition), 2006.
2. Thomas and Finney, *Calculus and Analytic Geometry*, (Pearson Education, Eleventh (Indian) Edition), 1998.
3. Feller, W. *An Introduction to Probability Theory and its Applications*, Vol. 1, (Wiley), 1968.

Reference book(s)

1. Jain, R. K. and Iyengar, S. R. K. *Advanced Engineering Mathematics,* Third Edition, (Narosa publishing house, India), 2009.
2. Veerarajan T., *Engineering Mathematics for first year*, (Tata McGraw-Hill, New Delhi), 2008.
3. Ramana, B. V. *Higher Engineering Mathematics*, (McGraw Hill, India), 2010.
4. Hoel P. G., Port S. C. and Stone C. J., *Introduction to Probability Theory*, (Universal Book Stall, New Delhi), 2003.
5. Ross, S., *A First Course in Probability*, (Pearson Education, India), 2002.

BA201	Economics	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: None

Module 1:
Basic Principles and Methodology in Economics. Demand and Supply analysis; Elasticity measurement. Theory of the Firm and Market Structure-Perfect Competition, Monopoly, Monopolistic Competition, Duopoly, and Oligopoly.
Basic Macroeconomics- National income, (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, inflationary growth and Phillips Curve.
Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy

Module 2:
Public Sector Economics –Welfare, Externalities, Labour Market. Public utilities, public and private expenditure, and public income. Taxation.

Module 3:
Elements of Business/Managerial Economics and forms of organizations. Cost & Cost Control – Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows).
Business Forecasting – Elementary techniques.

Module 4:
Indian economy - Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity.
Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization.
Employment–Informal, Organized, Unorganized, Public, Private.
Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors.
Module 5:Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights.

Books / References

1. Salvadore, Dominik. (2009). *Microeconomics: Theory and Applications.* Oxford University Press.
2. D. N. Dwivedi. (2011). Microeconomics. Pearson Education.
3. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia
4. V. Mote, S. Paul, G. Gupta(2004), Managerial Economics, Tata McGraw Hill
5. Misra, S.K. and Puri (2009), Indian Economy, Himalaya
6. Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration .

ME201	Solid Mechanics	L-T-P-Cr-CH: 3-1-0-4-4	Prerequisites: ME102

Objectives:

- To provide basic concepts and principles of solid mechanics.
- To teach how to calculate stresses and deformations of objects under external loadings, such as axial load, thermal load, internal pressure, bending, and torsion.
- To give an idea how to apply the knowledge of solid mechanics in solving engineering problems.

Contents:

Simple Stress and Strain: Introduction, Stress at a point, Types of stress, Strain, Shear and Normal strain. Stress-strain diagram, True stress and True strain, Hooke's law, Poisson's ratio, Material properties for

isotropic materials and their relations, Generalized Hooke's law, Stress-strain relationship. Statically indeterminate systems, Stresses induced in compound bars, Thermal stresses and strains. **(6L + 2T)**

Transformations of Stress and Strain: Components of stress, Stresses on an inclined plane or Transformation of plane stress, Principal stress and Principal planes, Maximum shearing stress and plane of maximum shearing stress, Mohr's circle for plane stress, Stresses in thin-walled sections, Principal strains, Direction of principal strains and maximum shearing strain, Mohr's circle for plane strain. **(6L + 2 T)**

Shear Force and Bending Moment diagrams: Axial loaded members, beams, relation between load, shear force and bending moment, drawing of shear force and bending moment diagram for different loading condition of beams. **(4L + 2T)**

Torsion: Introduction, circular shaft under torsion, stepped shaft and shaft of varying sections, shafts in series and parallel. Bending Stress in Beams: Stresses due to bending: pure Bending, transverse shear. **(4L + 2T)**

Bending of Beams: Pure Bending; Neutral axis; Theory of simple bending (Bending Equation of beam); section modulus; combined stresses due to bending, torsion and axially loading. **(4L + 1T)**

Deflection of Beams: Introduction, elastic curve, slope and deflection at a point - double integration method, principle of superposition, Macaulay's method, area moment method. **(4L + 2T)**

Energy Methods: Strain energy; Toughness; Resilience; Strain energy due to axial, torsion, bending and transverse shear; Castigliano's theorem; Reciprocity theorem, Principle of virtual work; Minimum potential energy; statically indeterminate systems. **(4L + 1T)**

Column: Introduction to buckling, Euler critical (buckling) load for long columns, effective or equivalent length, slenderness ratio. **(3L + 1T)**

Miscellaneous topics: Unsymmetrical bending, shear center and shear flow. **(3 lectures + 1 tutorial)**

(Total: 38 lectures + 14 tutorials)

Course Outcomes:

On successful completion of this course students will be able to

CO1: Recognize physical phenomena in the context of Solid Mechanics.
CO2: Demonstrate understanding of the theories of Solid Mechanics for deformable bodies.
CO3: Apply mechanics of deformable bodies to solve engineering problems.
CO4: Demonstrate understanding of the relationships among loads, member forces and deformations with stresses and strains.
CO5: Demonstrate understanding of the assumptions and limitations of the theories of Solid Mechanics
CO6: Competence in problem identification, formulation and solution.

Textbooks:

1. Hearn, E.,J., *Mechanics of Materials 1*. Elsevier, 3rd edition, 2008.
2. Hearn, E.,J., *Mechanics of Materials 2*. Elsevier, 3rd edition, 2008.
3. Popov, E. P. *Engineering Mechanics of Solids*. Pearson, 2nd edition, 2010.

References:

1. Beer, F. P. and Jhonston, E. R. Jr. et al. *Mechanics of Materials*. Tata McGraw Hill, New Delhi, 5th edition, 2009.
2. Pytel, A. and Singer, F. L. *Strength of Materials*. Addision Wesley (AWL), 4th edition, 1999.
3. Timoshenko, S. *Strength of Materials Vol. I*. CBS Publication, New Delhi, 3rd edition, 2004.

4. Timoshenko, S. *Strength of Materials Vol. II*. CBS Publication, New Delhi, 3rd edition, 2004.
5. Hibbeler, R. C., *Mechanics of Materials*, Prentice Hall, 8th edition, 2011.
Shames, I. H. and Pitarresi, J. M., *Introduction to Solid Mechanics*, PHI Learning, 3rd edition, 2009.

ME202	Fluid Mechanics I	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME102

Objectives:

i. Introduce the students to the subject of Fluid Mechanics and its applications in Industry and research.
ii. Train the students to apply the principles of Mechanics for finding different forces on fluid elements.
iii. Introduce the principles and applications of fluid kinematics.
iv. Understand the governing equations of fluid mechanics and learn to apply the same for solving various problems of engineering applications.
v. Introduce the concept and importance of similarity and dimensional analysis.
vi. Make the students capable of applying the Navier-Stokes equations for solving problems on viscous incompressible flows through ducts
vii. Impart competence to the students for solving problems of the standards pertaining to standards of the various national level competitive examinations like GATE, UPSC, PSUs etc.

Contents:

Introduction: Definition of fluid, concept of fluid continuum, fluid properties (viscosity, surface tension, vapour pressure and compressibility etc.), types of fluid, Newton's Law of viscosity, power law model for non-Newtonian fluid **(2L + 1T)**

Fluid Statics: Forces on fluid element (body force and surface force), pressure force on a fluid element, units and scales in pressure measurement, pressure measurement by Barometer, pressure/vacuum gauges and manometers, hydrostatic forces on plane and curved surfaces, Buoyancy and stability of submerged and floating bodies **(6L + 3T)**

Fluid kinematics: Velocity field, description of fluid motion by Lagrangian and Eulerian method, steady and unsteady, uniform and non-uniform flow, laminar and turbulent, material derivative, streamline, path line, streak line, translation, deformation and rotation of fluid element **(4L + 1T)**

Governing equations and its applications: Conservation of mass, momentum and energy, governing equations in differential and integral form, Reynolds transport theorem, application of momentum theorem for determination of forces on plane and curved surf aces due to impact of liquid jet and on pipe bends due to flow of fluid, Euler's equation and Bernoulli's equation, Application of Bernoulli's equation, measurement of flow through pipes using venturimeter, orificemeter and pitot tube, flow through orifice and mouthpiece **(6L + 2T)**

Physical similarity and dimensional analysis: Importance, geometric, kinematic and dynamic similarity, dimensional analysis, Buckingham's Pi-theorem with applications, Important dimensionless numbers **(4L + 1T)**

Potential flow theory: Stream function, vorticity, velocity potential, uniform flow, source flow; sink flow, vortex flow, superposition of elementary flows, Rankine half body, doublet, and flow past a cylinder **(4L + 1T)**

Viscous incompressible flow in duct: Stokes law and determination of viscosity, Navier stokes equations in Cartesian and polar coordinates; exact solution of Navier stokes equations, parallel flow in straight channels, Couette flow and Hagen Poiseuille flow, major and minor loss, friction factor, turbulent pipe flow, Moody's diagram, pipe network analysis of multiple pipe system, Hardy- Cross method
(6L + 3T)

(Total: 32 lectures + 12 tutorials)

Course Outcomes:

On the successful completion of the course, the student would be able to:

CO1: Have the knowledge of fluid properties for solving related application-oriented problems.
CO2: Calculate the hydrostatic forces on fluid elements and submerged/floating objects.
CO3: Evaluate the kinematic parameters of fluids like velocity, acceleration and rotation.
CO4: Apply the governing equations of fluid flow to find out the forces due to impact of jet on solid surfaces, and solve problems related to pipe flows and flow-measurements.
CO5: Apply the principles of physical similarity and dimensional analysis to engineering problems.
CO6: Identify the conditions under which exact solutions of the incompressible Navier-Stokes equations can be found and solve fully-developed, viscous incompressible flow problems through ducts.

Textbooks:

1. White, F. M. *Fluid Mechanics*. McGraw-Hill Education, 8th edition, 2015.
2. Chakrabarty, S., Som, S. K. and Biswas, G. *Introduction to Fluid mechanics and Fluid Machine*s. Tata McGraw Hill, 3rd edition, 2012

References:

1. Pritchard, P. J. *Fox and McDonald's Introduction to Fluid Mechanics.* John Wiley and Sons Inc., 8th edition, 2011.

ME203	Material Science	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: Nil

Objectives:

This course on "Material Science" aims to:

(i) introduce the students to different materials and their various properties and applications.
(ii) understand the concept of materials engineering and different strengthening mechanisms.
(iii) increase interest on advanced materials for design.
(iv) understand the criteria for selection of materials during design and manufacturing.

Contents:

Classification and Properties of Engineering Materials: Bonds in solids and characteristics of metallic bonding, General classifications, properties and applications of alloy steel, stainless steel, cast iron and non-ferrous materials like copper-aluminum- and nickel- based alloys. **(5L)**

Introduction to Ceramic, Polymeric and Composites materials **(5L)**

Crystal Systems and Imperfections: Crystallography, Miller Indices for directions and planes, Voids in crystals, Packing density, Crystal imperfections: point, line, surface and volume defects **(5L)**

Dislocations: Characteristics, Types and generation of dislocations, Deformation mechanisms and strengthening mechanisms in structural materials **(5L)**

Phase Diagrams and Phase Rules: Principles and various types of phase diagrams, Fe- Fe3C diagram, TTT and CCT diagrams, Heat treatment in Steels, Pearlitic, bainitic and martensitic transformations **(8L)**

Hot working and cold working of metals: Recovery, re-crystallization and grain growth **(2L)**

Material testing: Tensile (stress-strain diagrams and related terminologies), Hardness, and Impact testing **(3L)**

Failure of metallic materials: Creep fatigue and fracture phenomena **(2L)**

Basic Ideas of Materials Selection and Design **(5L)**

(Total: 40 lectures)

Course Outcomes:

On successful completion of this course, students will be able to:

CO1: identify the general and advanced engineering materials, their properties and applications.
CO2: explain the need of advanced and non-conventional materials.
CO3: identify the criteria for selection of materials during design and manufacturing.
CO4: correlate material properties with design considerations.
CO5: present the outcome carried out in the form of group projects on material characterization and different manufacturing aspects.

Textbooks:

1. Callister, W. D. *Material Science and Engineering - An Introduction.* John Wiley & Sons, 7th edition, 2007.
2. Dieter, G. E. *Mechanical Metallurgy*. McGraw Hill, 3rd edition, 1988.

References:

1. Smith, W. F. *Principles of Materials Science*. McGraw Hill, 2003.
2. Raghavan, V. *Materials Science and Engineering*. Prentice Hall, 6th edition, 2015.

ME208	**Manufacturing Technology I**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: Nil**

Objectives:

This course on "Manufacturing Technology I" aims to:

(i) give detailed knowledge in metal casting, metal working and metal joining processes.
(ii) correlate different engineering materials and design considerations with their manufacturing techniques.
(iii) increase interest on advanced manufacturing technology, automated and non-conventional manufacturing systems.

Contents:

Introduction to manufacturing processes **(2L)**

Casting processes: Types and stages of casting processes, Various foundry casting techniques viz. sand casting, die casting, continuous casting, centrifugal casting and investment casting, Types and properties of molding materials, pattern materials and core materials, Flow properties of molten metal, Gating and rising systems, Use of chills and chaplets; Principles of solidification of molten metal during casting, Directional solidification, Casting defects and their remedies, Quality assurance **(15L)**

Joining Processes: Principles and applications of welding, brazing, soldering and solid-state joining processes, Weldability of different materials and their metallurgical and mechanical aspects, Welding defects and inspection **(10L)**

Metal Forming / working Processes: Principles, analysis and application of various metals forming techniques viz. forging, rolling, extrusion, drawing, sheet metal forming, super plastic deformation, Forming defects and their remedies **(10L)**

Powder metallurgy and its Applications **(3L)**

(Total: 40 lectures)

Course Outcomes:

On successful completion of this course, students will be able to:

CO1: gain detailed knowledge on different industrial manufacturing processes, advanced or non-conventional manufacturing systems.
CO2: can correlate different engineering materials and design considerations with their manufacturing techniques.
CO3: prepare for advanced workshop practice.
CO4: initiate project based on metal casting, metal working and metal joining processes.

Textbooks:

1. Campbell, J. S. *Principles of Manufacturing Materials and Processes*. Tata McGraw Hill, 1st edition, 2004.
2. Kalpakjian, S. and Schmid, S.R. *Manufacturing Engineering and Technology*. Pearson/Prentice Hall, 7th edition, 2013.

References:

1. Ghosh, A. and Mallik, A. K. *Manufacturing Science.* East West Press, 2nd edition, 2010.
2. Rao, M. J. *Manufacturing Technology: Foundry, Forming and Welding*. McGraw Hill Higher Ed, 4th edition, 2013.

ME 217	ME Lab (Design) I	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: Nil

Objectives:

i. To understand the physical verification of different theories related to engineering mechanics, solid mechanics, theory of machine and mechanical vibration,
ii. To estimate mechanical properties of material,
iii. To understand the deformation behavior of material,
iv. To understand the kinematic and dynamic characteristics of mechanical device,
v. To design, perform, analyze, and report writing on experiment or on different prototypes of engineering systems as a group.

Contents:

Engineering Mechanics Laboratory:

Verification of the parallelogram and triangle law of forces; Verification of reaction forces in a simply supported beam; Verification of Hooke's law with the help of a coil spring; Determination of coefficient of friction by the inclined plane apparatus; Evaluation of centroid of different planar objects. **(5P)**

Strength of Material Laboratory:

Determination of percentage of elongation, yield strength and ultimate strength employing uniaxial tensile and compression test on mild steel bar; Vickers hardness test; Brinell hardness test; Rockwell hardness test; Determination of toughness of steel by impact testing (Izod test and Charpy test). **(7P)**

Theory of Machine Laboratory:

Study on the influence of inertia upon velocity and acceleration; Study on gyroscopic apparatus; Study of whirling of shafts phenomena; Study on centrifugal governor; Study of static and dynamic balancing of an unbalanced system; Demonstration of various kinematic models and their applications. **(7P)**

Vibration Laboratory:

Finding location of the centre of percussion of a compound pendulum; Finding the stiffness of a spring and acceleration due to gravity g of a spring-mass system; Undamped vibration absorber; Force and free undamped vibration of a rigid body; Force and free damped vibration of a rigid body. **(7P)**

(Total: 26 Practicals)

Course Outcomes: After successful completion of the course, the student will

CO1: be able to understand the measurement of mechanical properties of materials,
CO2: have understood the importance of fundamental science and engineering skills that are needed in engineering.
CO3: be able to characterize the dynamic behavior of mechanical systems,
CO4: have experienced the many stages in performing, analyzing and reporting of experimental data, comparison of the results with the relevant theories and eventually reporting the results both orally and written in a team environment.

References

1. Kumar, K. L. *Engineering Mechanics*. Tata McGraw Hill, 4th edition, 2017.
2. Thomson W. T., Dahleh M. D. and Padmanabham C. *Theory of Vibrations with Applications*. Pearson, 5th edition, 2008.
3. Popov, E. P. *Engineering Mechanics of Solids*. Pearson, 2nd edition, 2010
4. Ghosh, A. and Mallik A. K. *Theory of Mechanisms and Machines*. EWP publications, New Delhi, 3rd edition, 2014.

Semester IV

BT 201	**Biology**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: None**

Biological Structures and Organization:
- Biological macromolecules, cellular organization, cell types, membrane structures and functions.
- Cellular energetics: Structure of Mitochondria, Energy transduction; Structure of Plastids (chloroplast), Photosynthetic light and dark reaction.

Biological systems:
- Muscular skeletal system, Nervous system (overview of the major human sensory organs and their (functioning), Cardiovascular system.

Biological Information:
- DNA : Structure, Genetic code, Central dogma in Molecular Biology.
- Protein synthesis
- Biological data and Bioinformatics.
- Signal transduction in plants and animals

– Basic concepts.

Text/Reference:

1. N Hopkins, J W Roberts, J A Steitz and A M Weiner, “Molecular Biology of the Gene”, J Watson, 4th Ed. Benjamin Cummings, Singapor, 1987.
2. J L Tymoczko, L Stryer, “ Biochemistry”, J M Berg, 5th Ed. W H Freeman & Co, New York, 2002
3. Dr. C CChatterjee, “Human Physiology”, 11th Ed., Vol I & II, Medical Allied Agency, Kolkata, 1987
4. Guyton, “Human Physiology”.

ME205	**Thermodynamics**	**L-T-P-Cr-CH: 3-1-0-4-4**	**Prerequisites: Nil**

Objectives:

i. To introduce the students to basic thermodynamic laws
ii. Familiarize the students to the idea to be able to heat, work and thermal efficiency and state the different forms of energy.
iii. To be able to apply the steady-flow energy equation or the First Law of Thermodynamics to a system of thermodynamic components (heaters, coolers, pumps, turbines, pistons, etc.) to estimate required balances of heat, work and energy flow.
iv. Orient the students towards ability to estimate thermodynamic properties of substances in gas and liquid states.
v. To be able to apply ideal cycle analysis.

Contents:

Introduction and basic concepts: Basic definitions, thermodynamic systems and control volumes, properties, states, thermodynamic equilibrium, change of state, processes and cycles **(3L + 1T)**

Temperature: Zeroth law, thermometers and thermocouple, international temperature scale Energy transfer: Work transfer, pdV and other types of work transfer, heat transfer, specific heat at constant pressure and volume, latent heat, comparison of heat and work **(4L + 2T)**

First law of thermodynamics: First law for a closed system undergoing a cycle and change of state , internal energy, enthalpy, PMM-I, limitations of first law, non-flow and flow processes; steady state, steady flow and transient flow processes; application of first law to steady flow process, steady flow energy equation(SFEE) **(6L+ 4T)**

Second law of thermodynamics: Kelvin Plank statement, Claussius statement, Irreversibility, Carnot Cycle, Corollaries of Carnot's theorem, Applications of Second Law to closed and open systems, heat engine, heat pump and refrigerator, PMM-II, entropy, Claussius theorem, Claussius inequality, T-ds Relations, entropy principle and its application, entropy generation in closed and open system, absolute entropy and third law of thermodynamics **(7L + 5T)**

Availability: Definition, quality concept of energy, Reversible work and irreversibility, Exergy balance in closed and open system, Second law efficiency, Guoy Stodola theorem **(4L + 3T)**

Properties of pure substance: Definition, p-v, T-s and h-s diagram of pure substance (water), properties of steam, use of steam tables and charts (Mollier diagram) **(3L + 2T)**

Introduction to IC Engines: Introduction to Power Cycle: Carnot, Rankine and Modified Rankine Cycle. **(2L + 2T)**

(Total: 29 lectures + 19 tutorials)

Course Outcomes:

On the successful completion of the course, the student would be able to:

CO1: Discuss the use of boundaries in open and closed systems.
CO2: Define the meaning of the state of a working substance.
CO3: Understand concepts of heat, work, and energy.
CO4: Explain basic thermodynamic properties and units.
CO5: Develop and apply the continuity equation for open and closed systems.
CO6: Derive and discuss the first law of thermodynamics.
CO7: Explain properties of solids, liquids, and vapors.
CO8: Use thermodynamic diagrams.
CO9: Discuss basic thermodynamic cycles and systems.
CO10: Apply the second law of thermodynamics to thermal cycles.

Textbooks:

1. Cengel, Y. A. and Boles, M. A. *Thermodynamics, an Engineering Approach*. McGraw-Hill Education, 8th edition, 2014.
2. Nag, P.K. *Engineering Thermodynamics*. Tata McGraw Hill, 5th edition, 2013.

Reference Books:

1. Borgnakke, C. Sonntag, R.E. *Fundamentals of Thermodynamics*. John Wiley and Sons, 8th edition, 2014.
2. Moran,M.J., Shapiro, H.N., Boettner, D.D. and Bailey, M.B., *Principles of Engineering Thermodynamics*. S.I. version, John Wiley and Sons, 8th edition, 2011.

ME209	Fluid Mechanics II	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME202

Objectives:

i. To introduce the students to the principles and applications viscous laminar and turbulent fluid flows.
ii. To provide an insight into boundary-layer flows.

iii. Familiarize the students with the principles and applications of hydraulic machines
iv. To give exposure of compressible flow problems.
v. Enable the students to solve practical engineering problems related to fluid dynamics
vi. Orient the students towards research fields in experimental and computational fluid dynamics.
vii. To make the students competent to solve any problems of the standards of various competitive examinations including GATE, UPSC and PSUs.

Contents:

Introduction to Boundary Layer concepts: Boundary layer flow, Boundary layer equations, the flat plate boundary layer, definition of boundary layer, displacement, momentum and energy thickness, Blasius similarity solution, Von Karman momentum integral equation, separation of boundary layer. Flow past immersed bodies. **(4L + 2T)**

Turbulent flow: Laminar turbulent transition, derivation of Governing equations for turbulent flow, turbulent boundary layer equation, Prandtl's mixing length hypothesis, Universal velocity distribution law, and friction factor correlation **(4L + 2T)**

Compressible flow: Introduction, Speed of sound; adiabatic and isentropic steady flow, Mach-number relations, isentropic flow with area changes, Normal-shock wave, Rankine-Hugoniot relations, performance of nozzles, Fanno and Rayleigh flow **(9L + 4T)**

Turbo machinery: Euler-equation for turbo-machines, impulse turbine and reaction turbine, Pelton wheel, Francis turbine, Kaplan/propeller turbine, water hammer and surge tank, Rotodynamic and positive displacement pumps, working principle of reciprocating pump, air vessel, Centrifugal pump, its components and working principle, performance characteristics of centrifugal pump vis-à-vis system characteristics, dimensionless terms, specific speed, Cavitation and net positive suction head. **(10L + 5T)**

(Total: 27 lectures + 13 tutorials)

Course Outcomes:

On the successful completion of the course, the student would be able to:

CO1: Solve laminar and turbulent pipe-flow problems.
CO2: Analyze and solve laminar and turbulent boundary-layer problems.
CO3: Solve compressible-flow problems involving isentropic flows, flows with normal shocks, flow through a converging-diverging nozzle with shocks, compressible-flow problems involving friction and heat transfer
CO4: Carry out performance analysis of Pelton, Francis and Kaplan turbines, reciprocating and centrifugal pumps.
CO5: Extend the knowledge of dimensional analysis and similitude to the analysis of turbo machines.

Textbooks:

1. White, F. M. *Fluid Mechanics*. McGraw-Hill Education, 8th edition, 2015.
2. Anderson Jr., J. D. *Modern Compressible Flow with Historical Perspective.* McGraw-Hill Education (India) Pvt. Ltd., 3rd edition, 2017.

References:

1. Chakrabarty, S., Som, S. K. and Biswas G. *Introduction to Fluid mechanics and Fluid Machine*s. Tata McGraw Hill, 3rd edition, 2012.
2. Zucker, R. D. and Biblarz, O. *Fundamentals of Gas Dynamics*. John Wiley and Sons, 2nd edition, 2002.

ME214	Kinematics of Machinery	L-T-P-Cr-CH: 2-1-0-3-3	Prerequisites: ME102

Objectives: This is a fundamental course for the undergraduate students in Mechanical Engineering. The objectives of the course are to

i. introduce the important concepts like kinematic pairs, degrees of freedom, kinematic chains, kinematic inversions, etc.,
ii. introduce analytical and graphical methods for kinematic analysis of planar mechanisms,
iii. introduce various problems related to the dimensional synthesis of the linkages,
iv. introduce fundamentals of cams and different types of gears and gear trains.

Contents:

Introduction: Basic kinematic concepts; Kinematic pairs; Plane and space mechanisms; Kinematic chains; Kinematic diagrams, Limit and disguise of revolute pairs; Kinematic inversion; Equivalent linkages; Mobility and range of movement. (**8L + 3T**)

Kinematic analysis of plane mechanisms: Displacement analysis; Instantaneous centre of velocity; Aronhold-Kennedy theorem of three centres; Velocity and acceleration analysis (graphical and analytical); Velocity and acceleration images. (**6L + 3T)**

Dimensional synthesis of linkages: Two and three position synthesis - graphical method, Freudenstein's equations; Importance of Chebyshev accuracy points in approximate synthesis. (**3L + 2T**)

Cams: Classification of followers and cams; Radial cam nomenclature; Description of follower movement; Analysis of follower motion; Determination of basic dimensions of cams. (**5L + 3T)**

Gears: Gearing action; Fundamental law of gearing; Properties and characteristics of involute action; Introduction to helical, Spiral, Bevel, and Worm gears; Gear trains. (**4L + 2T**)
(Total: 26 Lectures + 13 Tutorials)

Course Outcomes:

On the successful completion of the course, the student will:

CO1: be able to appreciate and apply the framework acquired during this course to analyze and synthesize the mechanisms and machines for real-life problems/situations,
CO2: get help while going through higher level courses on machine design and solid mechanics,
CO3: get motivated to take up advanced courses like robotics etc.

Textbooks

1. Uicker, J. J., Pennock G. R. and Shigley J. E. *Theory of Machines and Mechanisms*. Oxford University Press, New Delhi, 5th edition, 2017.
2. Ghosh, A. and Mallik A. K. *Theory of Mechanisms and Machines*. EWP publications, New Delhi, 3rd edition, 2014.

References

1. Rattan, S. S. *Theory of Machines*. MacGraw Hill Education (India) Private Limited, New Delhi, 4th edition, 2014.
2. Rao, J. S. and Dukkipati R. V. *Mechanism and Machine Theory*. New Age International Publishers, New Delhi, 2006.
3. Bevan, T. *The Theory of Machines*. Pearson, New Delhi, 3rd edition, 2014.
4. Wilson C. E. and Sadler J. P. *Kinematics and dynamics of Machinery*. Pearson, 3rd edition, 2013.
5. Waldron K. J., Kinzel G. L. and Agrawal S.K. *Kinematics, Dynamics and Design of Machinery*. Wiley, 3rd edition, 2016.

ME215	**Mechanical Measurements and Instrumentation**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: Nil**

Objectives:

i. To introduce students with the fundamentals of measuring devices.
ii. Provide exposure to different measuring instruments in use.
iii. Enable the students to solve practical engineering problems related to metrology.

iv. Enable students to be competent to solve problems of the standards of various competitive examinations.

Contents:

Introduction to Metrology: General concepts, Definition of different metrological terms, metrology and methods of measurement, Classification of standards, Accuracy of Measurements Precision, Accuracy, Sensitivity, Calibration, Readability, Repeatability, Magnification; Errors in measurements, Limits, Fits and Tolerances, Interchangeability **(3L)**

Mechanical measurements: Linear measurements, Angular and Taper measurements, Screw thread measurements, Gear measurements, circularity measurements, surface finish, straightness and flatness measurements **(6L)**

Assessing Experimental Data: Static performance characteristics: Errors in measurements: Types and sources of errors, methods of elimination or reduction of error, sensitivity, linearity, resolution etc of instruments. Uncertainty analysis **(4L)**

Statistical analysis of Experimental Data: Gaussian distribution of error, least square method of fitting data, linear regression method **(6L)**

Dynamic Performance Characteristics: Zero, first and second order instruments, Signal conditioners: bridge circuit, amplifiers, filters etc. **(3L)**

Sensors and Transducers: Definition, classification and detail description of important transducers **(8L)**

Measurements: Basics of measuring instruments, description of instruments used for Displacement Measurements, Pressure measurements, Force measurements, Acceleration, Torque measurements, Flow measurements, Temperature measurements, Strain measurements **(12L)**

(Total: lectures 42)

Course Outcomes:

On the successful completion of the course, the student would be able to:

CO1: Learn the basics of the science of metrology.

CO2: Identify problems associated to measuring devices and measurements.

CO3: Apply their acquired knowledge to solve problems related to measurements and instrumentation.

CO4: Apply their learning and understanding in the design and working of measuring instruments according to need.

Textbooks:

1. Jain, R.K. *Engineering Metrology*. Khanna Publishers, New Delhi, 21st edition, 2009.
2. `Nakra, B.C. and Chaudhry, K.K. *Instrumentation Measurement and Analysis*. Tata McGraw Hill, New Delhi, 4th edition, 2016.

References:

1. Beckwith, T.G. Marangoni, R.D. and Lienhard, J.H. *Mechanical Measurements*. Pearson Prentice Hall, 6th edition, 2007.
2. Holman, J.P. *Experimental Methods for Engineers*. Mc-Graw Hill, 8th edition, 2012.
3. Rajput, R.K. *Mechanical Measurements and Instrumentation.* S. K. Kataria and Sons, New Delhi, 2012.

ME216	Manufacturing Technology II	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: ME208

Objectives: The main objective of this course is

i Applying the knowledge of metal cutting and machining in solving practical machining problems dealing with variety of tool materials and machining operations.
ii Introduce the basic principles that govern the principles of metal cutting and machining.
iii Establish the underlying principles related to Non conventional machining processes, surface finishing techniques and NC machining.
iv Impart competence to the students for solving problems of the standards pertaining to standards of the various national level competitive examinations like GATE, UPSC, PSUs etc.
v Make the students capable of applying the jig and fixtures design conditions in predicting effective jig and clamp designs for different machining conditions and techniques.

Contents:

Metal Cutting: Classification of metal removal processes, Mechanics, Chip formation, Surface finish and Machinability, Heat generation and cutting temperature, Cutting fluids **(10L)**

Cutting Tools: Tool geometry, Tool materials and properties, Tool wear and tool life, Tooling: jigs and fixtures **(8L)**

Setting and Operations on machine tools: Lathe, Milling, Shaping, Slotting, Planning, Drilling, Boring, Broaching, Reaming, Grinding, Thread rolling and Gear cutting machines, Gear hobbing, Super finishing processes **(10L)**

Batch production **(2L)**

CNC Machines: NC, CNC, DNC and FMS **(4L)**

Unconventional Machining: Electro-chemical, Electro-Discharge, Ultrasonic, LASER, Electron Beam, Water Jet, Abrasive Jet **(4L)**

Rapid prototyping and rapid tooling **(2L)**

(Total: 40 lectures)

Course Outcomes:

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

CO1: Identify the different aspects of machining science and machine tools.

CO2: Explain the increased need of advanced, automated and non-conventional machining processes.

CO3: Analyze the cutting tool geometry and design a single point cutting tool for shaping operation.

CO4: Demonstrate a practical understanding of machining operations and fabrication techniques, and to be able to make realistic suggestions for the evaluation of metal cutting behaviour.

CO5: Understand the underlying principles of non-conventional machining and make sound prediction on the selection of specific techniques based on metal cutting behaviour.

CO6: Identify the conditions under which exact solutions for jigs and fixture designs for effective work holding in different machining conditions.

Textbooks:

1. Kalpakjian, S. and Schmid, S.R. *Manufacturing Engineering and Technology*. Pearson/Prentice Hall, 7th edition, 2013.
2. Ghosh, A. and Mallik, A. K. *Manufacturing Science.* East West Press, 2nd edition, 2010.

References:

1. Hazra Choudhury, S.K., Hazra Choudhury, A.K. and Roy, N. *Elements of Workshop Technology Vol II*. Media Promoters and Publishers Pvt. Ltd., Mumbai, 2017.
2. Lal, G.K. *Introduction to machining science*. New Age International Publishers, New Delhi, 3rd edition, 2015.

Semester V

ME308	**Heat and Mass Transfer**	**L-T-P-Cr-CH: 3-1-0-4-4**	**Prerequisites: ME205**

Objectives:

i. To have a sound knowledge about different modes, mechanisms, laws and equations related to heat and mass transfer and its practical applications.
ii. To make the students know about the application of numerical methods in solving heat transfer problems, e.g., 1-D, 2-D and 3-D heat conduction, convection and radiation.
iii. To make the learner able to design and model various parts and machineries such as heat exchanger, fin, boiler, condenser etc., involving heat and mass transfer.
iv. To make the foundation of students to perform research work based on the heat and mass transfer related problems in further study.

Contents:

Modes of heat transfer, Conduction; Convection; Radiation, steady and unsteady heat transfer **(1L)**

Fourier law of heat conduction, general heat conduction equation, 1-D and 2-D steady state conduction, conduction though plane and composite wall, critical thickness of insulation, conduction with heat generation, 1-D unsteady conduction-Lumped capacitance and analytical methods **(7L + 3T)**

Fins, generalized equation for fins, fin performance and design considerations, heat flow through various types of fins (e.g. circular, rectangular and triangular fins) **(5L + 2T)**

Fundamentals, free and forced convection; external and internal flows; laminar and turbulent flow; Forced convection through pipe and over cylinder, order of magnitude analysis of momentum and energy equations; hydrodynamic and thermal boundary layers; dimensional analysis, Nusselt number; Prandtl number, Stanton number, Reynolds-Colburn analogy, Free convection from a vertical, horizontal and inclined plate, Free convection from vertical and horizontal cylinders; heat transfer with phase change (boiling and condensation) **(10L + 3T)**

Stefan-Boltzmann law; Planck's law; emissivity and absorptivity; radiation heat exchange between black and gray surfaces, Electric network approach for radiation heat exchange, view factor **(6L+ 2T)**

Parallel and counter flow heat exchangers, LMTD and effectiveness-NTU methods of heat exchanger design; correction factor for multipass arrangement, heat transfer enhancement techniques **(5L+ 2T)**

Molecular diffusion; Fick's law; analogy between heat and mass transfer; evaluation of mass transfer coefficients by dimensional analysis **(3L + 1T)**

(Total: 37 lectures + 13 tutorials)

Course Outcomes:

On the successful completion of the course, the student will:

CO1: know the mechanisms of conduction, convection and radiation heat transfer with relevant laws and governing differential equations in one and multidimensional forms.
CO2: be able to solve steady and transient conduction problems involving simple to complex geometries both analytically and numerically.
CO3: be able to learn and analyze the free and forced convection along with boiling and condensation in the practical applications.

CO4: handle heat exchanger problems using NTU and LMTD methods.

CO5: have the knowledge of radiation heat transfer such as shape factor, electrical approach and radiation shield will help the learner in performing solar energy related design and modeling.

CO6: will get a foundation platform to carry out much heat and mass transfer related experimental and computational based projects as well as research works in future.

Textbooks:

1. Incropera, F.P., Bergman, T.L., Dewitt, D.P. and Lavine, A.S. *Fundamentals of Heat and Mass Transfer*. John Wiley and Sons, 7th edition, 2012.
2. Holman, J.P. *Heat Transfer*. McGraw Higher Edition, 10th edition, 2011.

References:

1. Ozisik, M.N. *Heat Transfer-A Basic Approach*. McGraw-Hill International Editions, 1985.
2. Bejan, A. *Convective Heat Transfer*. John Wiley and Sons, 4th edition, 2013.
3. Kreith, F., Bohn, M. and Manglik, R. *Principles of Heat Transfer*. Cengage Learning, 7th edition, 2011.
3. Cengel, Y.A., Ghajar, A.J. and Kanoglu, M. *Heat and Mass transfer.* McGraw Hill Education, 4th edition, 2011.

ME311	**Machine Design I**	**L-T-P-Cr-CH: 2-1-0-3-3**	**Prerequisites: ME201**

Objectives:

i. To make students familiar with different design and manufacturing considerations.
ii. To teach students how to apply the concepts of stress analysis and theory of failure to analyze and design of machine components
iii. To analyze different forces and stresses acting on machine components and their joints.
iv. To design various machine components and their joints.

Contents:

Introduction to mechanical engineering design: Overview of machine design, Need of design, Design procedure, Stress-strain, Strength, Rigidity, Engineering materials, Material considerations in design. (**3L**)

Design against static load: Mode of failure, Factor of safety, Theories of failure: Maximum normal-stress theory, Maximum shear-stress theory and distortion-energy theory. (**4L + 2T**)

Design against fluctuating load: Fluctuating stresses, Fatigue failure, Endurance limit, Stress concentration, Notch sensitivity, Soderberg, Goodman and Gerber diagrams, Fatigue design under combined stresses. (**4L + 2T**)

Design of shafts, keys and couplings: Shaft design for stresses (axial, bending and torsional) and combined loading, Shaft materials; Introduction to axle; Types of keys, Introduction to design of keys; Design of rigid and flexible couplings. (**4L + 3T**)

Joints: Permanent and detachable joints, Introduction to design of welded, bolted and riveted joint; Design of cotter and knuckle joints. (**4L + 2T**)

Belt and chain drives: Flat and V-belts, Belt slip and creep, Stresses in the belts, Belt materials, Chain drives. (**3L + 2T**)

Mechanical springs: Helical springs, Leaf springs, Spring materials, Design against static and fluctuating load. (**2L + 2T**)

Manufacturing considerations: Standardization, Limits, Fits and Tolerance. (**2L**)
(Total: 26 Lectures + 13 Tutorials)

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

CO1: analyze the forces and stresses acting on various machine components, in particular shafts, shaft couplings, keys, belts, chains, and springs; as well as in welded, bolted and riveted joints.
CO2: analyze and design of structural joints.
CO3: design such machine components and joints subject to various related design considerations, such as safety factor, service factor, stress concentration, and both static and dynamic failure criteria.
CO4: understand, identify and quantify failure modes of mechanical parts.
CO5: incorporate various manufacturing issues in design, such as limits, fits, and tolerance.

Textbooks:

1. Bhandari, V. B. *Design of Machine Elements*. McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 3rd edition, 2014.
2. Gope, P. C. *Machine Design: Fundamentals and Applications*. PHI Learning Pvt. Ltd., New Delhi, 2012.

References:

1. Bhandari V. B. *Machine Design: Data book.* McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 2014
2. Sharma P. C. and Aggarwal, D. K. *A Textbook of Machine Design*. S. K. Kataria and Sons, New Delhi, 13th edition, 2017.
3. Spotts, M.F., Shoup, T.E., Hornberger, L.E., Jayram, S.R., and Venkatesh, C.V. *Design of Machine Elements*, Pearson Education. New Delhi, 8th edition, 2006.
4. Norton, R. L. *Machine Design – An Integrated Approach*. Pearson, 2nd edition, 2012.
5. Shigley, J.E., Mischke, C.R., Budynas, R.G., and Nisbett, K.J. *Mechanical Engineering Design*. Tata McGraw-Hill, New Delhi, 2008.

ME313	Dynamics of Machinery	L-T-P-Cr-CH: 3-0-0-3-3	Prerequisites: ME214

Objectives: The main aim of this course is to provide a foundation for the modeling and analysis of dynamic systems. The objectives of the course are to

i. introduce and discuss various methods of formulating the dynamic equations of a given mechanical system,
ii. discuss the dynamic force and motion analysis of slider-crank mechanism and the balancing of inertia forces and moments in machines in detail,
iii. introduce one of the simplest mechanical feedback systems in the form of governors,
iv. introduce the concepts of stiffness and damping and discuss the methods of modeling the spring and damper elements in a mechanical system in case of single-dof and multi-dof systems,
v. consider the free and forced response of linear vibratory systems,
vi. introduce the phenomenon and concepts like beats, critical speed, vibration isolation, etc.

Contents:

Dynamic force and motion analysis of plane mechanisms: Motion of a rigid body subjected to a system of forces, D'Alembert principle and dynamic equilibrium; Dynamically equivalent link. (**5L)**

Dynamic analysis of plane mechanisms: Force-moment analysis of four bar mechanisms; Dynamics of slider-crank mechanism; Derivation of turning moment and turning moment diagram; Fluctuations in crankshaft speed and flywheel. (**7L**)

Governor: Types of governors; Characteristics and types of centrifugal governors; Hunting of centrifugal governors, control force diagrams of gravity and spring controlled governors. (**4L**)

Balancing of inertia forces and moments in machines: Balancing of rotating masses - internal and external balancing, Static and dynamic balancing; Multi-plane balancing; Determination of balancing masses; Balancing of rotors - field balancing; Balancing of internal-combustion engines (single cylinder, multi-cylinder, V-engines, direct and reverse crank method). (**8L**)

Vibrations in mechanical systems: Basic features of vibratory systems; Single-degree-of-freedom systems - free and forced vibrations, Viscous and coulomb damping, Harmonic excitation; Transmissibility and vibration isolation; Two and multi-degree of freedom systems, normal modes, matrix method; orthogonally

principle, modal analysis method, Continuous systems (longitudinal, torsional and transverse vibration of beam with different boundary conditions). (**11L**)

Gyroscopic actions in machines: Principle of gyroscopes; Gyroscopic forces and couple; Gyroscopic stabilization, Application of gyroscope to simple rotating machines, airplane, ship, automobiles etc. (**4L**)
(Total: 39 Lectures)

Course Outcomes: After going through this course, the students will be able to:

CO1: develop a logical framework to analyze a dynamical system,
CO2: develop models of spring and damping elements from the basic principles of mechanics of materials and fluid mechanics respectively,
CO3: develop and solve the equations of motion of single- and multi-degree of freedom physical systems under forced and free conditions,
CO4: compute the damped and undamped natural frequencies, the logarithmic decrement, the time constant and the damping factor and determine whether the system is stable or not.

Textbooks

1. Uicker, J. J., Pennock G. R. and Shigley J. E. *Theory of Machines and Mechanisms*. Oxford University Press, New Delhi, 5th edition, 2017.
2. Ghosh, A. and Mallik A. K. *Theory of Mechanisms and Machines*. EWP publications, New Delhi, 3rd edition, 2014.
3. Thomson W. T., Dahleh M. D. and Padmanabham C. *Theory of Vibrations with Applications*. Pearson, 5th edition, 2008.

References

1. Rattan, S. S. *Theory of Machines*. MacGraw Hill Education (India) Private Limited, New Delhi, 4th edition, 2014.
2. Rao, J. S. and Dukkipati R. V. *Mechanism and Machine Theory*. New Age International Publishers, New Delhi, 2006.
3. Bevan, T. *The Theory of Machines*. Pearson, New Delhi, 3rd edition, 2014.

ME314	**Applied Thermodynamics**	**L-T-P-Cr-CH: 3-1-0-4-4**	**Prerequisites: ME205**

Objectives:

i. To provide an understanding on the basic thermodynamic cycles of vapor and gas power generation.
ii. To study analysis of thermodynamic cycle efficiency and methods to improve cycle efficiency and net work output with emphasis on combined generation.
iii. To provide adequate knowledge on the working principles of the components of a steam turbine power plant.
iv. To provide knowledge on gas power cycle (Brayton cycle) and methods to improve cycle efficiency.
v. To acquaint students with the knowledge of jet propulsion.
vi. To provide a detailed overview of air standard cycles of Internal Combustion (IC) engines and their comparisons
vii. To equip the students with the knowledge of IC engine fundamentals, components and working principles including analysis of engine performance under various design and operating conditions.
viii. To familiarize students with the working principles of reciprocating, centrifugal and axial flow gas compressors
ix. To offer an in-depth understanding on psychrometric processes and cooling towers

x. To enhance the problem solving skills of students on the various topics the course

Contents:
Brief review on basic knowledge of thermodynamics **(1L)**

Vapor Power cycles: Rankine cycle and its representation in various co-ordinate systems, deviations of actual cycle from ideal cycle, Rankine cycle performance, and modifications of ideal Rankine cycle. Low Temperature Power Cycles, ideal working fluid and binary / multi-fluid cycles, cogeneration, **(5L+ 2T)**

Steam Generator (Boiler): Different types of boilers, Mountings and Accessories. **(2L + 1T)**

Condenser: Types of Condensers and their working principle. **(1L)**

Steam turbine: Impulse and reaction turbine, compounding of steam turbine, velocity triangle, efficiencies, degree of Reaction, reheat factor, governing of steam turbine. Steam Nozzles. **(6L + 2T)**

Psychrometry: Properties of moist air: psychrometry and psychrometric charts and processes, cooling towers. **(2L + 1T)**

Refrigeration: Vapor compression refrigeration cycle - in T-s and P-h plots, multi-pressure system, and Desirable properties of refrigerants. **(2L + 1T)**

IC engines: SI and CI engines, two- and four-stroke engines, Engine components, and their working, engine design and operating parameters and its effect on engine performance mean effective pressure, efficiency and specific fuel consumption. Air standard cycles and Air fuel engine cycles, analysis of actual cycle and various losses. Pressure-crank angle diagram, Carburetor and fuel injection systems **(7L + 2T)**

Gas power cycle and gas turbines: Basic components of Gas Turbine plant, Brayton cycle, deviations of actual cycle from ideal cycle, Reheat, intercooling, regeneration cycles. Combined gas and steam cycles, low temperature power cycles. **(5L + 2T)**

Introduction to jet propulsion: Turbojet, turbofan, turboprop engines **(1L)**

Reciprocating air compressors: Components and working principle, Process representation in p-V plane, calculation of work done, and multistage compression with intercooling. **(4L + 1T)**

Introduction to Centrifugal and Axial-Flow Compressors: (3L+ 1T)

(Total: 39 lectures + 13 tutorials)

Course Outcomes:
Towards the end of the course the student would be able to

CO1: Analyze the basic, reheat and bled steam power cycles in order to carry out calculations on system performance.

CO2: Construct steam turbine velocity diagrams in order to determine stage calculations mathematically

CO3: Use steam tables and h-s charts to carry out calculations on steam power plant system performance.

CO4: Explain the working of different boilers, condensers and other components of a steam turbine power plant.

CO5: Analyze various gas turbine power plant system arrangements in order to perform heat, work, efficiency, air-fuel ratio, etc. calculation

CO6: Determine thrust developed, efficiencies and fuel consumption of jet engines

CO7: Analyze single and multi-stage reciprocating air compressor cycles in order to carry out calculations on machine performance.

CO8: Construct velocity diagrams for various blade designs of a centrifugal compressor to determine work input, blade efficiency etc.

CO9: Evaluate the performance of Otto, Diesel and Dual cycle IC engines.

CO10: Explain combustion phenomena, injection and ignition systems of IC engines.

CO11: Draw and analyze valve timing diagrams of four stroke IC engines.

CO12: Solve numericals related to this course in various competitive examinations like GATE, UPSC, PSU's etc.

CO13: Study related advanced application-oriented courses such as Gas Turbine and Compressor, Heat Exchanger Design, Refrigeration and Air-conditioning, Compressible Flow, Energy Conservation and Waste Heat Recovery, Advanced Thermodynamics etc.

CO14: Suggest/ implement/ innovate methods of improving efficiency of a thermal power plant along with combined generation/ co-generation.

Textbooks

1. Cengel, Y.A. and Boles, M.A. *Thermodynamics, An Engineering Approach*. McGraw Hill Education, 8th edition, 2014.
2. Nag, P.K. *Basic and applied thermodynamics*. Tata McGraw Hill, New Delhi, 2nd edition, 2010.
3. Nag, P.K. *Power plant Engineering*. McGraw Hill Education (India), 4th edition, 2014.

Reference Books

1. Borgnakke, C. and Sonntag R.E. *Fundamentals of Thermodynamics*. John Wiley and Sons, 8th edition, 2013.
2. Moran, M.J., Shapiro, H.N., Boettner, D.D. and Bailey, M.B., *Principles of Engineering Thermodynamics*. S.I. version, John Wiley and Sons, 7th edition, 2014.
3. Rogers, G. F. C and Mayhew, Y. R. *Engineering Thermodynamics Work and Heat Transfer*. Pearson Education, 4th edition, 1992.
4. Eastop, T. D. and McConkey, A. *Applied Thermodynamics for Engineering Technologists*. Longman, 5th edition, 1993.

ME315	ME Lab (Manufacturing) II	L-T-P-Cr-CH: 0-0-2-2-4	Prerequisites: ME203, ME216

Objectives:

1. To provide an understanding of manufacturing methods through metal cutting, machining and welding.
2. To get an idea of the dimensional and form accuracy of products.

Contents:

Manufacturing:

- Measurement of tool angles and radius of single point cutting tool,
- Determination of cutting forces and surface roughness with variation of cutting parameters, shear plane, and chip thickness ratio.

(5P)

Machine Tools and Machining:

- Selection of Cutting tools – single point cutting tool, carbide tipped tools. Tool signature
- Selection of cutting speeds and feeds for various machining operations.
- Machining operations on lathe, shaping, slotting, milling and grinding machines.

(7P)

Welding Process:

- Gas Welding (Oxy acetylene Welding)

- Shielded metal arc welding – selection of welding parameters, electrodes.
- Soldering
- Brazing

(6P)

Manufacturing Automation:

- NC, CNC, CAM, FMS -3
- NC part programming -2
- Simulation and manufacturing-2

(8P)

(Total: 26 Practicals)

Course Outcomes:

Upon completion of this course, students will be able to

CO1: Perform machining using various manufacturing techniques.
CO2: Evaluate the accuracy and tolerance of components production
CO3: Perform metal arc welding operations on jobs.
CO4: Understand the advanced manufacturing techniques such as NC and CNC and write their part programming.

References

1. Hazra Choudhury, S.K. Hazra Choudhury A.K. and Roy N. *Elements of Workshop Technology Vol II*. Media Promoters and Publishers Pvt. Ltd., Mumbai, 2017.
2. Ghosh, A. and Mallik, A. K. *Manufacturing Science.* East West Press, 2nd edition, 2010.
3. Boothroyd, G and Knight, W.A. *Fundamentals of Metal machining and Machine Tools*. CRC press, Boca Raton, 3rd edition, 2005.
4. Kalpakjian, S. and Schmid, S.R. *Manufacturing Engineering and Technology*. Pearson/Prentice Hall, 7th edition, 2013.

Semester VI

IC361	**Accounting and Financial management**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: None**

Unit 1: Introduction of Accounting

Meaning and Scope of accounting; Objectives, nature and functions of accounting; Advantages and limitations of accounting;Accounting as a measurement and valuation principle; Accounting Principles; Accounting as an Information System;Basis of Accounting – Cash and accrual system of Accounting; Branches of accounting; Accounting and management control.

Unit 2: Basic Accounting Process

Accounting process from recording of transactions till preparation of Trial Balance-Concept of assets, liabilities, capital, income and expenses; Balance Sheet equation; Classification of receipts/income and payments/expenditure into capital and revenue; Rules for Debit and credit; recording of transactions; The Journal and subsidiary books, ledger accounts- posting of transactions; Adjusting entry; Bank Reconciliation Statement.

Unit 3: Trial Balance and Final Accounts

Trial Balance – meaning and importance, adjusted trial balance, Difference in Trial Balance; Errors and rectification entries thereof.

Need for measurement of income, Realization principle vs. Accrual principle; accounting period, Matching revenue and expenses.

Manufacturing Account, Trading Account, Concept of Gross profit and Net profit,, Need and meaning of Profit and Loss Account, Forms and contents of Profit and Loss Account, Concept of Balance Sheet, Classification of items in a balance sheet; Format of Company Balance Sheet, Preparation of Final Accounts; Cash Flow statement.

Accounting for depreciation; method of inventory valuation

Unit 4: Accounting Standards and emerging concepts in Accounting
Introduction to Accounting Standards and IFRS converged Ind AS, Human Resource Accounting, Corporate Social Accounting etc.; computerized Accounting System and accounting software,

Unit 5: Study of Annual Reports of Companies; Analysis, interpretation and Judgment building
(Assignment based)
Text Books:
1. Ramachandran, N. and Kakani, R.K. Financial Accounting for Management. 3/e, TATA McGraw-Hill Education Pvt. Ltd: Noida, 2011.
2. BhattacharjeeAshis K. Financial Accounting for Business Management. Prentice Hall India: New Delhi, 2006.
Reference Books:
1. Anthony Robert N., Hawkins David, Merchant Kenneth A. ,Financial Accounting-Text and Cases, McGraw-Hill Higher Education; 13 edition (1 June 2010)

ME312	**Machine Design II**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: ME311**

Objectives:

i. To provide an overview of code, standards and design guidelines for mechanical design.
ii. Impart the student with the ability to design of machine components and systems.
iii. To improve the problem-solving and decision-making abilities of the students.
iv. To develop an appreciation for parameter optimization and design iteration.
v. To understand the importance of the use of lubricant at the contact surface in mechanical systems.

Contents:

Introduction to design process, morphology of design and designing methods. (**1L**)

Brakes: Types of brakes, Energy absorbed by the brakes, Design of block, band and disc brakes (Internal and external shoe); Absorption, Transmission and torsion dynamometer. (**5L**)

Clutches: Classification, application and design of friction clutches, Disc or plate clutches, Cone clutches. (**5L**)

Power screw: Forms of thread, I.S.O. Metric screw thread, Bolted joint in tension, Torque required for bolt tightening, Stresses in screw, Efficiency of screw. (**4L**)

Design of gears: Design of spur gears, Helical gears, Bevel gears and worm gears, Lewis equation, Lewis form factor, Design based on strength dynamic and wear loads. (**10L**)

Introduction to design of gear boxes, Flywheel and Pulleys. (**2L**)

Bearings: Types of bearings, Ball and **r**oller bearings, Static and dynamic load carrying capacity, Load life relationship, Taper roller bearing, Bearing materials. (**5L**)

Lubrications: Basic mode of lubrication, Hydrodynamic lubrication theory, Hydrostatic and hydrodynamic bearings (e.g. Journal). (**4L**)

Introduction to design of IC engine components (Cylinder, Piston, Connecting rod and Crankshafts). (**2L**)

Introduction to the computer aided design. (**1L**)

(Total: 39 Lectures)

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

CO1: analyze stress and strain in machine components, in particular brake, clutch, power screw, gears and bearing under different loading conditions.
CO2: design different machine components and explain the failure of such components.
CO3: recognize the need for friction drives and positive drives

CO4: determine load carrying capacity and related parameters of bearing.
CO5: predict the frictional behaviour at the sliding interface in mechanical system.

.**Textbooks:**

1. Bhandari, V. B. *Design of Machine Elements*. McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 3rd edition, 2014.
2. Gope, P. C. *Machine Design: Fundamentals and Applications*. PHI Learning Pvt. Ltd., New Delhi, 2012.

References:

1. Bhandari V. B. *Machine Design: Data book.* McGraw-Hill Edu. (India) Pvt. Ltd., New Delhi, 2014.
2. Shigley, J.E., Mischke, C.R., Budynas, R.G., and Nisbett, K.J. *Mechanical Engineering Design*. Tata McGraw-Hill, New Delhi, 2008.
3. Faculty of Mechanical Engineering – PSG College of Technology, *Design Data (Data book of Engineering)*. Kalaikathir Achchagam, 8th edition, 2007.
4. Ramamurti, V. *Computer Aided Mechanical Design and Analysis*. Tata McGraw Hill, 3rd edition, 1996.
5. Burr, A. H. and Cheatham, J. B. *Mechanical Analysis and Design*. Prentice Hall Inc., 2nd edition, 1997.
6. Dixon, J. R. *Design Engineering: Inventiveness, Analysis and Decision Making*. TMH, New Delhi, 1980.

ME316	**Computer-Aided Engineering**	**L-T-P-Cr-CH: 1-0-2-3-5**	**Prerequisites: Nil**

Course Objectives:

(i) To impart knowledge to the students related to solid modeling and system modeling of thermo-fluid systems.

(ii) To train the students on modern techniques for solving real-life-engineering problems using commercial-software packages.

Contents:

Introduction to Computer-Aided Modeling: Basic drafting, Modelling of parts and assembly drawing using standard software packages **(2 L + 3 P).**

Introduction to Structural Analysis: Introduction to Finite Element Analysis: Basic engineering analysis of Beams, Trusses, Plates; Stress analysis of structure with individual and combined loading under Mechanical, Thermal and Thermo-Mechanical loading **(5 L + 3 P)**.

Introduction to Computational Fluid Dynamics: Mathematical nature the governing partial differential equations (PDEs) for fluid flow and heat transfer, Introduction to Finite Difference Method (FDM) and Finite Volume Method (FVM), Preprocessor, Solver and Postprocessor of a commercial CFD package, SIMPLE Algorithm, RANS Based Turbulence Models, Shear Stress
Transport Model, Near Wall Treatment **(5 L + 2 P)**.

Modeling of fluid systems: Geometry modeling using a standard commercial package, specification of boundary conditions, free-stream conditions and flow properties, user-defined functions **(2 L + 2 P)**

Use of commercial fluid-flow solvers to solve the following problems **(16 P)**:

i. Steady and unsteady-state temperature profiles in solids under heat conduction
ii. Solution of viscous, laminar, incompressible flow over immersed bodies – car bodies, airfoils
iii. Solution of viscous, laminar, incompressible flow through internal passages – nozzles, flow through check valves
iv. Simulation of flows through Heat exchangers- conjugate heat transfer problems
v. Estimation of Nusselt number in forced, free and mixed-convection problems,
vi. Computation of viscous-supersonic flows over wedges and cones
vii. Simulation of Oil-Tank Sloshing
viii. Simulation of pulsating flows through mufflers

ix. Modeling and analysis of beams under different loading conditions using FEM
x. Modeling of different machine components using standard software package
xi. Analysis of those machine components using FEM
xii. Modeling of complex structures using standard software package
xiii. Analysis of complex structures using FEM

(Total: 14 lectures + 26 practical classes = 40 classes)

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

CO1: Model and analysis of physical system involving structural and thermal applications

CO2: Use commercial-software packages to simulate engineering problems involving structural loading, fluid flow and heat transfer.

References:

1. Bhat, N. D. and Panchal V. M., *Machine Drawing*. Charotar Publishing House, Court Road, Anand, India, 48th Edition, 2013.
2. Srinivas, P., K., Sambana, C. and Datti, R. J., *Finite Element Analysis using ANSYS@ 11.0*. PHI, New Delhi, 2012.
3. Versteeg, H. K. and Malalasekera, W., *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*. Pearson, 2nd Edition, 2009.
4. Anderson, D. A., Tannehill, J. C., and Pletcher, R. H., *Computational Fluid Mechanics and Heat Transfer*. CRC Press, 3rd Edition, 2012.
5. Munford, P. and Normand, P. *Mastering Autodesk Inventor 2016 and Autodesk Inventor LT*. John Wiley Sons, 2016.
6. Kent, L.L. *ANSYS Workbench Tutorial Release 14*. SDC Publications, 2012.
7. *ANSYS FLUENT Tutorial guide Release 15.0.* ANSYS Inc., 2013.

ME317	**ME Lab (Thermal) III**	**L-T-P-Cr-CH: 0-0-2-2-4**	**Prerequisites: ME205, ME209**

Objectives:

i. To discuss and practice standard measurement techniques of fluid mechanics and their applications

ii. To learn the determination of amount of heat transfer in various modes of heat including condensation and boiling

iii. To familiarize the basic working principle and components of vapour compression, vapour absorption refrigeration system.

iv. To cover the terminology associated with psychrometry.

Content:

Fluid Mechanics: Demonstration of Bernoulli's Theorem, Flow meter demonstration: Determination of discharge coefficients of flow meters (Venturimeter and Orificemeter), Study of Impact of jet on flat, curved and semispherical surfaces, Osborne Reynolds demonstration **(8P)**

Turbomachinery: Demonstration of Centrifugal pump: (i) Introduction to pump characteristic, (ii) Effect of inlet head on pump performance, (iii) System characteristic analysis (determination of operating point), Demonstration of Pelton Turbine: (i) Comparison of Pelton wheel performance using spear and throttle valve **(6P)**

Heat Transfer: Demonstration of Conduction, Convection and Radiation mode of heat transfer.

- Conduction: Thermal conductivity of insulating slabs
- Convection: To determine heat transfer co–efficient for forced convection, dropwise and filmwise condensation apparatus and critical heat flux in pool boiling apparatus, Heat transfer in vertical cylinder natural convection apparatus

- Radiation: Stefan Boltzmann apparatus
- Heat exchangers, and Heat pipe: To study the heat transfer phenomena in parallel/counter flow arrangements and calculate overall heat transfer coefficient with concentric tube heat exchanger, Effectiveness of shell and tube heat exchanger apparatus, Heat pipe demonstrator, Cooling tower test rig. **(9P)**

Refrigeration and Air Conditioning: Demonstration of working of refrigerating and air conditioning system: To determine the Coefficient of performance for Vapour compression refrigeration system, Vapour absorption refrigeration system. To determine psychometric properties using Air conditioning test rig. **(4P)**

(Total: 27 Practicals)

Course Outcomes:

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

CO1: Understand and apply the laws of fluid mechanics to practical applications

CO2: Understand the basic laws of heat transfer.

CO3: Understand the fundamentals of convective heat transfer process, like boiling, condensation.

CO4: Understand the working of refrigeration system and psychometric processes.

References:

1. Chakrabarty, S., Som, S. K. and Biswas, G. *Introduction to Fluid mechanics and fluid machines*. Tata McGraw Hill, 3rd edition, 2012
2. Massey, B.S. and Smith, J. W. *Mechanics of fluids*. Taylor and Francis, 9th edition, 2012.
3. Incropera, F.P. and Dewitt, D.P. *Fundamentals of Heat and Mass Transfer*. John Wiley and Sons, 5th edition, 2009.
4. Stoecker, W.F and Jones, J.W., *Refrigeration and Air Conditioning*. McGraw-Hill International Editions, 2nd edition,1986
5. White, F. M. *Fluid Mechanics*. Tata McGraw Hill, 7th edition, 2010
6. Kundu, P.K. Cohen, I.M. and Dowling, D.R. *Fluid Mechanics*. Elsevier, 5th edition, 2012
7. Ozisik, M.N. *Heat Transfer-A Basic Approach*. McGraw Hill, 1985.
8. Bejan, A. *Convective Heat Transfer*. John Wiley and Sons, New York, 3rd edition, 2004.
9. Arora, C.P. *Refrigeration and Air Conditioning*. Tata McGraw-Hill, 2nd edition, 2000.

ME318	**Mini Project**	**L-T-P-Cr-CH: 0-0-2-2-4**	**Prerequisites: Nil**

The students will carry out mini projects in groups of 2 or 3 students under the supervision of a faculty member or joint supervision by some Industry Personnel. The Mini Project is likely to be extended as the final-year project work of the individual groups

Semester VII

ME401	**Industrial Systems Engineering**	**L-T-P-Cr-CH: 3-0-0-3-3**	**Prerequisites: None**

Objectives: The main objective of this course is

i. Applying the student's knowledge of mathematics in solving practical industrial engineering problems on operations research, forecasting, and network analysis.
ii. Introduce the basic principles that govern the principles of product design, plant layouts, and value analysis.
iii. Establish the underlying principles related to mechanisms of Maintenance planning, Quality control and Inventory control.
iv. Explain the concepts of network analysis, sales forecasting and operations research.
v. Impart competence to the students for solving problems of the standards pertaining to standards of the various national level competitive examinations like GATE, UPSC, PSUs etc.

Contents:

Industrial Engineering: Introduction, Production Planning and Control, Product design, Value analysis and value engineering, Plant location and layout, Equipment selection (**8 lectures)**

Plant location and layout; Equipment selection, Maintenance planning; Job, batch and flow production method, Group technology, Work study, Time and Motion study; Work/Job Evaluation, Inventory control **(8 lectures)**

Concept of TPM and TQM, Job, batch, and flow production methods, Group technology, Work study, Time and motion study, Incentive schemes, Work/job evaluation, Inventory control- deterministic model only (**8 lectures)**

Manufacturing planning: MRP, MRP-II, JIT, CIM, Quality control - Statistical process control, Acceptance sampling, Total quality management, Quality engineering; (**6 lectures)**
Forecasting, Scheduling and loading, Line balancing, Break-even analysis, Network Analysis – PERT and CPM, Inventory Control (**10 lectures)**

(Total: 40 lectures)

Course Outcomes:

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

CO1: Explain the basic underlying concepts of product design, plant layouts, and value analysis.

CO2: Create and solve problems related to Forecasting, Scheduling, Network analysis and breakeven analysis.

CO3: Explain the mechanisms of Maintenance planning, Quality control, Inventory control and Operations Research.

CO4: Apply and analyze various techniques of sales forecasting, linear programming transportation problem, and queuing theory for solving industrial problems.

CO5: Explain the basic underlying concepts of product design, plant layouts, and value analysis.

Textbooks

1. Telsang, M. T. *Industrial Engineering and Production Management*. S Chand and Company Limited, 2nd edition, 2006.
2. Paneerselvam, R. *Productions and Operations Management*. PHI learning Pvt. Ltd, 3rd edition, 2012.

Reference Books

1. Sharma, S. K. and Sharma, S. *Industrial Engineering & Organization Management*. S. Kataria and Sons, 3rd edition, 2016.

ME471	**Industrial Summer Training**	**L-T-P-Cr-CH: 0-0-0-2-0**	**Prerequisites: Nil**

Training will be of 12 weeks duration carried out during the summer break after the 6th semester.

The students will submit their reports in the 7th semester.

ME483	**Project I**	**L-T-P-Cr-CH: 0-0-4-4-8**	**Prerequisites: ME318**

The students will carry out project works in groups of 2 or 3 students each under the guidance of a faculty member or joint supervision with some Industry Personnel. The project shall consist of research/ design/ development/ implementation work.

Semester VIII

ME484	**Project II**	**L-T-P-Cr-CH: 0-0-8-8-16**	**Prerequisites: ME483**

The students will carry out project works in groups of 2 or 3 students each under the guidance of a faculty member or joint supervision with some Industry Personnel. A provision is present for a group to work for the entire semester in some Industry, if suitable opportunity arises. In that case the concerned students will be allowed to complete the course works for ME Elective VI and Open Elective IV through MOOCs. The project shall consist of research/ design/ development/ implementation work.