B. Tech. Mechanical Engineering
Four-Year Programme
Academic Curriculum (2015-16 onwards)

Second Year

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW *	MTE **	ETE
Autumn Semester		University Elective	3	0	0	3	3	10	40	50
	MA 14.201	Applied Mathematics	3	1	0	4	3	10	40	50
	ME 14.201	Mechanics of Solids	3	1	0	4	3	10	40	50
	ME 14.203	Engineering Thermodynamics	3	1	0	4	3	10	40	50
	ME 14.205	Material Science and Metallurgy	3	0	0	3	3	10	40	50
	ME 14.211	Mechanics of Solids Laboratory	0	0	2	1	2	20	40	40
	ME 14.213	Thermodynamics Laboratory	0	0	2	1	2	20	40	40
	ME 14.215	Computer Aided Machine Drawing	0	0	2	1	2	20	40	40
	Sub Total		**15**	**3**	**6**	**21**				
		Proficiency (Non Credit) †	-	-	-	1		100		

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW *	MTE **	ETE
Spring Semester	ME 14.202	Kinematics of Machines	3	1	0	4	3	10	40	50
	ME 14.204	Fluid Mechanics	3	1	0	4	3	10	40	50
	ME 14.206	Design of Machine Elements-I	3	0	0	3	3	10	40	50
	ME 14.208	Production Technology-I	3	0	0	3	3	10	40	50
	ME 14.210	Automobile Engineering	3	0	0	3	3	10	40	50
	ME 14.212	Production Technology Practice-I	0	0	2	1	2	20	40	40
	ME 14.214	Fluid Mechanics Laboratory	0	0	2	1	2	20	40	40
	ME 14.216	Design of Machine Elements Practice-I	0	0	2	1	2	20	40	40
	ME 14.218	Comprehensive-I	0	0	0	3	3	0	0	100
	Sub Total		**15**	**2**	**6**	**23**				
		Proficiency (Non Credit) †	-	-	-	1		100		

1st Year	2nd Year	3rd year	4th year	Total credits Point
21+22	21+23	21+23	23+21	175

B. Tech. Mechanical Engineering
Four-Year Programme
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Third Year

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW*	MTE**	ETE
Autumn Semester		University Elective	3	0	0	3	3	10	40	50
	ME 14.301	Dynamics of Machines	3	1	0	4	3	10	40	50
	ME 14.303	Design of Machine Elements-II	4	0	0	4	3	10	40	50
	ME 14.305	Heat and Mass Transfer	3	1	0	4	3	10	40	50
	ME 14.307	Fluid Machinery	3	0	0	3	3	10	40	50
	ME 14.311	Design of Machine Elements Practice-II	0	0	2	1	2	20	40	40
	ME 14.313	Fluid Machinery Laboratory	0	0	2	1	2	20	40	40
	GE 301	Interpersonal Communication Laboratory	0	0	2	1	2	20	40	40
	Sub Total		**16**	**2**	**8**	**21**				
	GE 305	Proficiency (Non Credit) †	-	-	-	1		100		

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW*	MTE**	ETE
Spring Semester	ME 14.302	Computational Methods	3	0	0	3	3	10	40	50
	ME 14.304	I. C. Engines	3	0	0	3	3	10	40	50
	ME 14.306	Production Technology-II	3	0	0	3	3	10	40	50
	ME 14.308	Metrology & Quality Control	3	0	0	3	3	10	40	50
		Elective-I	3	1	0	4	3	10	40	50
	ME 14.310	Computational Methods Laboratory	0	0	2	1	2	20	40	40
	ME 14.312	I. C. Engines Laboratory	0	0	2	1	2	20	40	40
	ME 14.314	Production Technology Practice-II	0	0	2	1	2	20	40	40
	ME 14.316	Metrology & Quality Control Laboratory	0	0	2	1	2	20	40	40
	ME 14.318	Comprehensive-II	0	0	0	3	3	100		
	Sub Total		**15**	**2**	**6**	**23**				
	GE 306	Proficiency (Non Credit) †	-	-	-	1		100		

1st Year	2nd Year	3rd year	4th year	Total credits Point
21+22	21+23	21+23	23+21	175

B. Tech. Mechanical Engineering
Four-Year Programme
Academic Curriculum (2015–16 onwards)

Fourth Year

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW *	MTE **	ETE
Autumn Semester	ME 14.401	Thermal Engineering Systems	3	1	0	4	3	10	40	50
	ME 14.403	Refrigeration & Air Conditioning	3	1	0	4	3	10	40	50
	ME 14.405	Production Technology-III	3	0	0	3	3	10	40	50
	ME 14.407	Industrial Engineering & Operations Research	3	0	0	3	3	10	40	50
		Elective–II	3	1	0	4	3	10	40	50
	ME 14.409	Minor project	-	-	-	2	-	100		
	ME 14.411	Colloquium	0	0	2	1	-	100		
	ME 14.413	Industrial Training Seminar††	-	-	-	2	-	100		
	Sub Total		**15**	**3**	**2**	**23**				
	GE 405	Proficiency (Non Credit) †	-	-	-	1		100		

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW *	MTE **	ETE
Spring Semester	ME 14.402	Professional Values and Ethics in Engineering	3	0	0	3	3	10	40	50
	ME 14.404	CAD/CAM	3	0	0	3	3	10	40	50
	ME 14.406	Operations Management	4	0	0	4	3	10	40	50
	ME 14.408	CAD/CAM Laboratory	0	0	2	1	2	20	40	40
	ME 14.410	Major Project	-	-	-	10	-	100		
	Sub Total		**10**	**0**	**1**	**21**				
	GE 404	Proficiency (Non Credit) †	-	-	-	1		100		

*Theory: Assignments and regularity will be evaluated out of 10(ten) marks in a semester.
Practicals: Practical records and regularity will be evaluated 4 (four) times in a semester. Each evaluation will be out of 10 (ten) marks.
** Theory: Two mid-term examinations of 20 (twenty) marks each
Practicals: Viva/ Quizzes will be held 4 (four) times in a semester, each of 10(ten) marks.
† Evaluation of proficiency will be based on the participation in co-curricular activities.
†† Students will go for an industrial training programme of 8 (eight) weeks in the summer after the end of III year Spring semester examination.

N.B. The curricular structure is subject to revision from time to time, which will be duly notified.

1st Year	2nd Year	3rd year	4th year	Total credits Point
21+22	21+23	21+23	23+21	175

B. Tech. Mechanical Engineering
Four-Year Programme
Academic Curriculum (2015-16 onwards)

List of Electives to be offered in 2015-16

Elective I

S. No.	Course Code	Course Title
1	ME 14.320	Optimization Method in Engineering Design
2	ME 14.322	Vibration Engineering
3	ME 14.324	Advance Metal Casting & Welding
4	ME 14.326	Solar Energy Based Thermal System
5	ME 14.328	Turbo machinery
6	ME 14.330	Robotics

Elective II

S. No.	Course Code	Course Title
1	ME 14.415	Mechatronics
2	ME 14.417	Composite Material
3	ME 14.419	Non-Conventional Energy Resources
4	ME 14.421	Product Design and Development
5	ME 14.423	Human Factor in Engineering Design

B. Tech. First Year (All Branches, except Biomedical Eng. & CSE with IBM Specializations)
Four Year B. Tech. Programme
Academic Curriculum (2015-16 onwards)

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW	MTE	ETE
Autumn Semester	MDC003	Environmental Studies*(University Compulsory)	3	1	0	4	3	10	40	50
		Mody University Elective**	3	0	0	3	3	10	40	50
	MA-14.101	Mathematics I	3	1	0	4	3	10	40	50
	PY-14.101	Engineering Physics*	3	0	0	3	3	10	40	50
	CY-14.101	Engineering Chemistry**	3	0	0	3	3	10	40	50
	ME-14.101	Applied Mechanics**	3	1	0	4	3	10	40	50
	EE-14.101	Elements of Electrical Engineering*	3	1	0	4	3	10	40	50
	CS-14.101	Programming Language*	3	1	0	4	3	10	40	50
	ME-14.111	Computer aided Engineering Drawing**	0	0	4	2	2	20	40	40
	CS-14.111	Programming Lab*	0	0	2	1	2	20	40	40
	PY-14.111	Physics Lab*	0	0	2	1	2	20	40	40
	CY-14.111	Chemistry Lab**	0	0	2	1	2	20	40	40
	ME-14.112	Mechanical Workshop**	0	0	2	1	2	20	40	40
	EE-14.111	EEE Lab*	0	0	2	1	2	20	40	40
		Sub Total	**15/ 12**	**3**	**6/ 8**	**22* / 22****				
	GE 14.101	Proficiency (Non Credit) †	-	-	-	1	-	100		

*Autumn: Group I: CSE, ICT, BTMT (CSE, ECE) Spring: Group II: ECE, EE, ME, MBA (Tech) CSE, ECE
** Autumn: Group II: ECE, EE, ME, MBA (Tech) CSE, ECE Spring: Group I: CSE, ICT, BTMT (CSE, ECE)

	Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weightage (%)		
			L	T	P		Hours	CW	M T E	ETE
Spring Semester	MDC003	Environmental Studies*(University Compulsory)	3	1	0	4	3	10	40	50
		Mody University Elective**	3	0	0	3	3	10	40	50
	MA-14.102	Mathematics II	3	1	0	4	3	10	40	50
	PY-14.101	Engineering Physics*	3	0	0	3	3	10	40	50
	CY-14.101	Engineering Chemistry**	3	0	0	3	3	10	40	50
	ME-14.101	Applied Mechanics**	3	1	0	4	3	10	40	50
	EE-14.101	Elements of Electrical Engineering*	3	1	0	4	3	10	40	50
	EC-14.101	Basics of Electronics Engineering**	3	1	0	4	3	10	40	50
	CS-14.101	Programming Language*	3	1	0	4	3	10	40	50
	ME-14.111	Computer aided Engineering Drawing**	0	0	4	2	2	20	40	40
	CS-14.111	Programming Lab*	0	0	2	1	2	20	40	40
	PY-14.111	Physics Lab*	0	0	2	1	2	20	40	40
	CY-14.111	Chemistry Lab**	0	0	2	1	2	20	40	40
	ME-14.112	Mechanical Workshop**	0	0	2	1	2	20	40	40
	EE-14.111	EEE Lab*	0	0	2	1	2	20	40	40
		Sub Total	**12/ 15**	**3**	**8/ 6**	**22* / 22****				
	GE 14.102	Proficiency (Non Credit) ++	-	-	-	1	-	100		

*Spring: Group II: ECE, EE, ME, MBA (Tech) CSE, ECE Autumn: Group I: CSE, ICT, BTMT (CSE, ECE)
** Spring: Group I: CSE, ICT, BTMT (CSE, ECE) Autumn: Group II: ECE, EE, ME, MBA (Tech) CSE, ECE

MA-14.101 **Mathematics-I** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Calculus:** Review of basic concepts, partial differentiation, Euler's theorem on homogeneous functions, Taylor's series and Jacobian, maxima and minima of functions of two variables, asymptotes, tracing of simple Cartesian curves, length of plane curves, area bounded by the curves, multiple integrals (double and triple integrals, change of order of integration), physical interpretations and applications. [16]
2. **Three-dimensional Geometry**: Direction cosines and direction ratios of a straight line, equation of a plane, plane passing through intersections of two planes, equations of a straight line, the shortest distance between two skew lines, the equation of a sphere, intersection of plane and sphere. [10]
3. **Matrix Theory**: Rank of matrix, linear dependence and independence of vectors, solution of system of simultaneous linear equations, Eigen values, Eigenvectors of a matrix, statement of Cayley-Hamilton theorem (without proof) , reduction of a matrix to diagonal form, quadratic forms, linear transformation of a quadratic form, and applications. [10]
4. **Theory of Equations**: Introduction of polynomials, the relation between roots and coefficients, Cardon's method. [4]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj, New Delhi, 40th Edition, 2007.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2nd Edition 2007.
3. Narayan Shanti, Analytical Solid Geometry, S. Chand and Company, New Delhi, 1971

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, ISBN: 04717289777/0471726478, 9th Edition, 2005.
2. Ram Babu, Engineering Mathematics, 1st Edition, Pearson, New Delhi, ISBN: 978-81-317-26914.
3. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 2nd Edition 2001.

MA-14.102 **Mathematics-II** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Computational Methods**: Introduction and importance of numerical analysis, calculus of finite differences, interpolation schemes for equal and unequal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), solution of algebraic and transcendental equations by Newton-Raphson method, applications to Engineering. [13]
2. **Ordinary Differential Equations:** First order and first-degree differential equations (variable separable, homogeneous, linear, exact equations, linear differential equations of second order with constant and variable coefficients (complementary functions and particular integrals) and applications. [12]
3. **Partial Differential Equations**: Formation of partial differential equations, Lagrange's multipliers method for the solution of first order differential equations, separation of variables for nonlinear differential equations and applications. [5]
4. **Vector calculus**: Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, work done along a curve, integration of vectors, line integral (work done), surface integral, volume integral, physical interpretations and applications. [10]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj,New Delhi, 40th Edition, 2007.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited,New Delhi, 2nd Edition 2007.
3. Narayan Shanti, Analytical Solid Geometry, S. Chand and Company, New Delhi, 1971.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, ISBN: 04717289777/0471726478, 9th Edition, 2005.
2. Ram Babu, Engineering Mathematics, 1st Edition, Pearson, New Delhi, ISBN: 978-81-317-26914.
3. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 2nd Edition 2001.

PY-14.101 **Engineering Physics** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To make a bridge between the physics in school and engineering courses.

1. **Modern Physics**: Introduction to black body radiation spectrum, photoelectric effect, Compton effect. Wave-particle Dualism, deBroglie hypothesis, de Broglie wavelength, extension to electron particle, Davisson and Germer experiment, matter waves and their characteristic properties, phase velocity, group velocity and particle velocity, relation between phase velocity and group velocity, relation between group velocity and particle velocity, expression for deBr;oglie wavelength using group velocity. [8]
2. **Quantum Mechanics:** Heisenberg's uncertainty principle and its physical significance, application of uncertainty principle (non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom), wave function, properties and physical significance of wave function, probability density and normalization of wave function, setting up of one dimensional time independent Schrodinger wave equation, eigenvalues and eigenfunctions, application of Schrodinger wave equation, energy eigenvalues for a free particle, energy eigenvalues and eigenfunctions for a particle in a potential well of infinite depth. [7]
3. **Electrical Conductivity in Metals**: Free–electron concept, classical free electron theory Assumptions, drift velocity, mean collision time and mean free path, relaxation time, expression for drift velocity, expression for electrical conductivity in metals, effect of impurity and temperature on electrical resistivity of metals, Quantum free electron theory assumptions, Fermi – Dirac statistics, Fermi-energy, Fermi factor, density of states (No Derivation), expression for electrical resistivity / conductivity, temperature dependence of resistivity of metals, electron in a periodic potential, origin of the energy gap, band theory of solids, distinction of solids into metals, semiconductors and insulators. [8]
4. **Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials, types of polarization, equation for internal field in liquids and solids (one dimensional), Ferro and Piezoelectricity, frequency dependence of dielectric constant, important applications of dielectric materials, classification of dia, para and ferro-magnetic materials, hysteris in ferromagnetic materials, soft and hard magnetic materials, applications. [7]
5. **Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density), requisites of a Laser system, condition for laser action, principle, construction and working of CO_2 laser and semiconductor laser, applications of laser – Laser welding, cutting and drilling, measurement of atmospheric pollutants, holography–principle of recording and reconstruction of images, applications of holography, propagation mechanism in optical fibers, angle of acceptance, numerical aperture, types of optical fibers and modes of propagation, attenuation, application, block diagram discussion of point to point communication. [10]

Outcome(s):

- The student will be able to understand many modern devices and technologies based on lasers and optical fibers. A student can also appreciate various material properties which are used in engineering applications and devices.

Text Books:

1. S. O. Pillai, Solid State Physics, Sixth Edition, New Age International.
2. V. Rajendran, Engineering Physics, TMH.

Reference Book: 1.G. K. Shivkumar, Engineering Physics, Prism Book Pvt. Ltd.

CY-14.101 **Engineering Chemistry** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present-day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nanomaterials etc.

1. **Water treatment**: Hardness, types of hardness, determination of hardness by complex metric (EDTA) method, degree of hardness, boiler troubles: corrosion, sludge and scale formation, prevention of sludge and scale formation in boilers, methods of boiler water treatment: lime-soda process, permutit (zeolite) process, ion exchange methods, numerical problems based on water treatment (lime-soda process). [10]
2. **Organic and Inorganic Polymers:** Classification, functionality, types of polymerization, mechanism of addition polymerization, plastics: thermoplastic and thermosetting resins, preparation, properties and uses of Polyamides, Bakelite, Polyesters, Rubber, vulcanization of rubber, synthetic rubber viz. Buna-S, Buna-N, Butyl and Neoprene rubbers, Silicones-polysiloxanes and Sulphur based polymers. [8]
3. **Electrochemistry and Corrosion**: Classifications (Galvanic cell, electrolytic cell), types of electrodes (reference electrodes-standard hydrogen electrode, indicator electrodes- glass electrode), the origin of electrode potential, Nernst equation of electrode potential. electromotive force, electrochemical series. corrosion: definition and its significance, theories of corrosion, mechanism of corrosion, types of corrosion, Galvanic cell, and concentration cell, water line corrosion, pitting & stress corrosion (caustic embrittlement), protection against corrosion, corrosion control (corrosion inhibitors, cathodic protection - sacrificial anodic and impressed current cathodic protection), protective metallic coatings. [10]
4. **Fuels:** Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel, Bomb calorimeter, determination of LCV & HCV, petroleum: origin, composition, processing, cracking, synthetic petrol, refining, reforming, knocking, unleaded petrol, LPG as a gaseous fuel, numerical problems based on combustion. [6]
5. **New Engineering Materials**: Introduction: superconductors, high and low-temperature superconductors, organic electronic materials, fullerenes and nanomaterials, industrial applications of fullerenes and nanomaterials. [6]

Text Books:

1. Jain and Jain, Engineering Chemistry, 15th Edition, 2006, Dhanpat Rai Publishing Company.
2. S.S. Dara, A Text Book of Engineering Chemistry, 9th Edition, 2001, S. Chand & Company Limited.

Reference Books:

1. Atkins, Physical Chemistry, 7th edition P.W.
2. J.F. Shakelford, M.K.Murlidhara, Materials Science for Engineers, 6th Edition.
3. Bokris and Reddy, Modern Electrochemistry I, 2nd Edition, Springer.

ME-14.101 **Applied Mechanics** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open-ended engineering problems.
- To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.
- To provide the student with a thorough understanding of the concept, drawing, and the use of free-body diagrams.
- To be able to determine the Centre of Gravity and Moments of Inertia of simple geometric shapes and understand the physical applications of these properties.
- To understand the use and be able to perform calculations related to friction forces in engineering applications.

1. **Introduction:** Idealization of Mechanics, the concept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics. [3]
2. **Force Systems and Equilibrium**: Introduction to vector, Statically Equivalent Force systems, Free Body Diagram, Equations of equilibrium and their applications to the various system of forces. [8]
3. **Distributed Forces and Moment Of Inertia**: Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia. [5]
4. **Friction:** Introduction of friction, Laws of friction, wedge, screw, belt, rolling friction. [5]
5. **Tension, Compression, and Shear:** Normal stress and strain, Linear elasticity, Hooke's Law and Poisson's Ratio, Shear stress and shear strain, Relationship between modulus. [4]
6. **Beams:** Different support & load conditions, SFD, BMD [5]
7. **Kinematics of Particles**: Introduction, Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Tangential and normal coordinates, polar coordinates, Relative motion (Translating Axes), constrained motion of connected particles. [5]
8. **Kinetics of Particles:** Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum. [5]

Outcome(s):

- The students shall develop the ability to identify, formulate, and solve engineering problems related to forces and motion.

Text Books:

1. Timoshenko, S, Young, D.H, Rao, J.V, Engineering Mechanics, 4th edition TMH, 2010.
2. Merian, J.L, Kraige, L.G., Engineering Mechanics Vol I & II, 5th edition Wiley India 2010.

Reference Books:

1. Hibbeler, Gupta R. C., Engineering Mechanics, 11th ed., Pearson India, 2010.
2. Irving. H. Shames, Engineering Mechanics, Prentice Hall Book Company, 1966.

EE-14.101 **Elements of Electrical Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

1. **Introduction:** Background, major inventions, scope, significance and job opportunities in electrical engineering, brief overview of various energy resources. Apparatus used in generation, transmission, and distribution of electrical power and various industries. [3]
2. **D.C. circuits:** Review of circuit elements, voltage sources, current sources, ohms law, KVL, KCL, source transformation, mesh current and node voltage analysis of circuits. [5]
3. **Network Theorems**: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, star-delta transformation. [6]
4. **Single phase A.C. circuits:** Basic terminologies, average & RMS values of a.c. quantities, phasor representation, the response of R, L, C and their combination to a.c. excitation, the concept of power and power factor in a.c. circuits. [6]
5. **Three phase A.C. circuits:** Three phase supply, phase sequence, star connection, delta connection, the relationship between phase and line quantities in 3-phase circuits, measurements of three-phase power underbalanced condition. [6]
6. **Magnetic Circuits & Transformer**: Magnetic circuit, mutually coupled circuit, Transformer: working principle, emf equation, ideal & practical transformer, equivalent circuits, transformer testing: open circuit and short circuit test, losses, voltage regulation and efficiency. [8]
7. **Rotating Machines:** Electro-mechanical energy conversion, introduction to rotating machines and applications [6]

Outcome(s):

- The students shall develop an insightful knowledge on various fundamental elements and devices of electrical engineering.

Text Books:

1. Nagrath & Kothari, Theory and Problems of Basic Electrical Engineering, 2nd edition PHI Publication.
2. Fitzgerald & Kingsley, Basic Electrical Engineering, 3rd edition TMH publication.

Reference Books:

1. H.Cotton, Advanced Electrical Technology, CBS Publication.
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd Edition PHI Publication

EC-14.101 **Basics of Electronics Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course would facilitate the learner to acquire good exposure to electronics and communication engineering.

1. **Introduction:** Brief history of major inventions, scope, significance and job opportunities in electronics and communication engineering, Overview of various specializations in ECE, Electronic test and measurement equipment's, Specifications for electronic components. [3]
2. **Semiconductors:** Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect. [5]
3. **Diodes:** Introduction, Characteristic of ideal and real diode, Current components in the diode, load characteristics, Breakdown in the diode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers. [8]
4. **Transistors:** Introduction to PNP and NPN transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability. [8]
5. **Signals:** Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate. [4]
6. **Basics of Communication**: Definition, Block representation of communication system, Modulation – Definition, Need for modulation, Frequency translation, Types of modulation - Analog and Digital, Multiplexing – TDM and FDM. [6]
7. **Applications of Communication**: Introduction to - Optical Fiber, Transmission line, Waveguides, Satellite communication, and RADAR. [6]

Outcome(s):

- The learners are expected to have an overview of electronics and communication engineering and learn the introductory concepts in each of the specializations in ECE.

Text Books:

1. George Kennedy, Bernard Davis, Electronics Communication Systems, 3rd Edition, Tata McGraw-Hill, 2007.
2. Behrouz Forouzan, Data Communication, and Networking, 4th Edition, McGraw-Hill, 2006.
3. Robert L. Boylestad, Louis Nashelsky, Electronics Devices and Circuits Theory, 10th Edition, Prentice Hall, 2009.

Reference Books:

1. David A. Bell, Electronics Devices, and Circuits, PHI, 4th edition, 2008.
2. Wayne, Tomasi, Advanced Electronic Communication Systems, 6th edition, PHI, 2013.

CS-14.101 **Programming Language** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To learn principles of programming by the structured native language 'C'.
- To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1. **Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured programming, object-oriented programming, functional programming, logic programming, concurrent programming. [10]
2. **Fundamentals of 'C' language** : Character set, variables data types constants, arithmetic, relational and logical operators, type conversion, increment, decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*, *switch*, loops - *do-while*, *while*, *for*; *break, continue* and *goto* statements, labels. [10]
3. **Functions, pointers and Arrays**: Basics of functions, automatic, external, static and register variables, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, pointers and multidimensional arrays, command line arguments. [10]
4. **Structures, unions and file processing:** Basics of structures, structures, and functions, arrays of structures, pointers to structures, self-referential structures, unions, bit fields, the concept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file. [10]

Outcome(s):

- Students would be able to apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

Text Books:

1.Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education, 2013,
2.Ravi Sethi & K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,2013,

Reference Books:

1.Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education, 2000
2.E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education

ME-14.111 **Computer Aided Engineering Drawing** **Total Lectures: 40**

Credit: 0-0-4-2

Prerequisite(s): NIL

Objective(s):

- To improve the visualization skills.
- To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
- To impart the knowledge of understanding and drawing of simple engineering products.

1. **Introduction to Computer Aided Sketching**: Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and freehand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, the layout of the software, standard toolbar/menus and description of most commonly used toolbars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering. [8]
2. **Orthographic Projections**: Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, the First and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimensional Sketching, Sketching in Solid works, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination, and perpendicularity. [12]
3. **Projections of Lines, Planes, and Solids**: Lines inclined to both the principal planes, the projection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to the part module in Solid works: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features. [12]
4. **Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full, Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solid works: Standard 3 views, Auxiliary view, Section View, Projected view. [12]
5. **Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, the isometric projection of arcs. Solid models practice using Solid works part module. [8]

Outcome(s):

- Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
- Students will be able to know and understand the conventions and the methods of engineering drawing using Solid works.
- Students will be able to prepare simple drawings of engineering products.

Text Books:

1. N.D. Bhatt, "Engineering Drawing", Charotar Publishing House, 2013.
2. Prof. Sham Tickoo, Sandeep Prem Dass Solid works 2013 for Engineers and Designers Wiley Publication, 2013.

Reference Books:

1. Randy H. Shih, Solid works 2013 and Engineering Graphics: An Integrated Approach, SDC Books: Publications. 2013
2. David Planchard, "Engineering Graphics with Solid Works 2014 and Video Instruction", SDC Publications, 2013.

CS-14.111 **Programming Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To learn the implementation of programming language.

1. **C- Language Basics**: 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.
2. **Control Statements**: 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.
3. **Functions:** 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.
4. **Arrays:** 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.
5. **Pointers:** 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.
6. **Structure and Union**: 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.
7. **I/O and File Structure**: 5 application programs are to be written for the above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

Outcome(s):

- The students will be able to implement efficiently the logic into a program.

PY-14.111 **Physics Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To make the students gain practical knowledge to co-relate with the theoretical studies.

1. To study the material constant, temperature coefficient of current and Planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To determine the ballistic constant, K of a moving coil ballistic galvanometer with a standard capacitor of known capacity.
4. To determine the high resistance by the method of leakage of a condenser with the help of ballistic galvanometer.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome(s):

- After completion of the course, students would be able to develop the skills necessary to perform experiments in physics and acquire an experience of the methods used and analysis needed in experimental physics.

CY-14.111 **Chemistry Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

1. To determine the Total, Temporary and permanent hardness of water by EDTA method.
2. To determine the % of available chlorine in a sample bleaching powder.
3. To determine the alkalinity of given water sample.
4. To prepare urea formaldehyde resin.
5. To determine the Calorific value of a fuel by bomb calorimeter.
6. Determination of the strength of HCl by titrating it against NaOH pH metrically.
7. Determination of the strength of HCl by titrating it against NaOHconductometrically.

Outcome(s): On completion of this course, students will have the knowledge in

- Handling different types of instruments for analysis of materials using small quantities of materials involved for quick and accurate results.
- Carrying out different types of titrations for estimation of concerned in materials using comparatively more quantities of materials involved for good results.

ME-14.112 **Mechanical Workshop** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To learn various hand tools used in fitting, carpentry and sheet metal shop.
- To learn about lathe and drilling machine and their operations.
- To learn how various joints are made using wood and other metal pieces.

1. **Fitting Shop:** Prepare job that contains various fitting operation like filing, marking, measuring, cutting, drilling etc.
2. **Carpentry Shop:** Making of carpentry joint (T, L joint etc).
3. **Sheet Metal Shop:** Making job from the sheet (funnel, tray etc).
4. **Machine Shop:** Perform various operations like turning, step turning, facing, chamfering, knurling etc. on Lathe.

Outcome(s): Students will able to:

- Understand use of tools of Fitting, Carpentry & Sheet Metalworking operations
- Study and practice on lathe and drilling machine and their operations
- Acquire engineering skills in Fitting, Carpentry & Sheet Metalworking operations

EE-14.111 **EEE Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- The objective of this course is to introduce the students to the basic concepts of Electronics Engineering.
- The aim of this course is to study the fundamental aspects of Electronics Engineering.
- To acquire the knowledge of hardware and verify the results on Multisim software.
- This lab facilitates the students to get a comprehensive exposure to operations of AC and DC machines, measurements of various parameters and applications of electrical machines.

Practical to be performed on Hardware:

1. Introduction to basic electronics components and study of breadboard, CRO, function generator, multimeter, and D.C. power supply.
2. To plot VI characteristics of p-n junction diode and Zener diode.
3. To design a half wave rectifier with and without filter circuit and find the ripple factor.
4. To design a full wave rectifier with and without filter circuit and find the ripple factor.
5. Study of clipper and clamper circuits and implement on a breadboard.
6. To perform soldering and de-soldering to make a banana probe, BNC probe, and connection on PCB.
7. To conduct open circuit test and short circuit test on single phase transformer and to determine equivalent circuit parameters.
8. Measurement of three-phase power by using two wattmeter methods.
9. Speed control of DC machine by field current control method.
10. To construct a fluorescent tube wiring and to measure the voltage across tube rod, the voltage across choke and current.

Practical to be performed using Multi-Sim Software:

1. An Introduction to Electronic Circuit Simulation using **Multi-Sim Software**.
2. To verify Ohm's law and Kirchhoff's law.
3. Simulate half wave and full wave bridge rectifier.
4. To plot VI characteristics of p-junction diode

Outcome(s): After completion of the course, students would be able to:

- To use the technique, skills, and modern engineering tools necessary for engineering practice.
- Able to explain the basic concepts of basic electronics components.
- Able to describe& explain Clipper and Clamper circuits, V-I Characterization of p- n junction & Zener diode.
- The students shall develop an insightful knowledge on various ac and dc machines with their industrial applications.

Code ME 14.201 **Mechanics of Solids** **Total Lectures: 40**

Credit 3-1-0-4

Prerequisite(s): ME-14.101, MA-14.101

Objective(s):

- *To acquaint with the basic concepts of stress and deformation in solids.*
- *To practise the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.*
- *Learn the fundamental concepts of the method of superposition, flexibility method, and stiffness method as applied to problems involving statically determinate and indeterminate axial and torsional members, and beams.*
- *Understand the concepts necessary to design the structural elements and pressure vessels.*

1. **Compound Stress and Strains:** Introduction, objective of the course, stresses on inclined sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's stress circle, three dimensional state of stress & strain, generalized Hook's law. **[6]**
2. **Shear Forces and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate (uniform and variable loading) beams including beams with internal hinges for different types of loading. **[4]**
3. **Trusses:** Introduction, simple truss and solution of simple truss, method of joints and method of sections. **[4]**
4. **Stresses in Beams:** Pure Bending**,** normal stresses in beams, shear stresses in beams due to transverse and axial loads, composite beams. **[4]**
5. **Deflection of Beams:** Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams, combined bending & torsion of solid & hollow shafts. **[6]**
6. **Columns and Struts:** Buckling and stability, slenderness ratio, combined bending and direct stress, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling, Rankine Gordon formulae, examples of columns in mechanical equipments and machines. **[8]**
7. **Thin cylinders:** Introduction, difference between thin walled and thick walled pressure vessels, Thin walled cylinders, hoop and axial stresses and strain, volumetric strain. **[4]**
8. **Curved Beams:** Bending of beams with large initial curvature, position of neutral axis for rectangular and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression. **[4]**

Outcome(s):

- *Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tri-dimensional elastic solids.*
- *Solve problems relating to pure and non-uniform bending of beams and other simple structures.*
- *Solve problems relating to torsional deformation of bars and other simple tri-dimensional structures.*
- *Understand the concept of buckling and be able to solve the problems related to isolated bars.*

Text Books:

1. Gere J. M & Goodno B. J, "Strength of Materials ", CENGAGE Learning, Latest Edition.
2. Popov E. P, "Mechanics of Solids", PHI, New Delhi, Latest Edition.

Reference Books:

1. Timoshenko, S.P., and Gere, J.M., "Mechanics of Materials", 2nd Ed., CBS Publishers.
2. Bansal R K, "Strength of Materials", Laxmi Publications.
3. Beer, Johnston, Dewolf and Mazurek, "Mechanics of Materials", Tata McGraw Hill.
4. Subramanian R, "Strength of Materials", Oxford University Press, New Delhi Latest Edition.
5. Sadhu Singh, "Strength of Materials", Khanna Publishers.
6. Punmia, Jain and Jain, "Mechanics of Material", Laxmi Publications.

Code ME 14.203

Engineering Thermodynamics

Total Lectures: 40

Credit: 3-1-0-4

Prerequisite(s): MA 14.101, MA 14.102

Objective(s):

- *Identify and use units and notations in thermodynamics*
- *State and illustrate the first and second laws of thermodynamics*
- *Identify and explain the concept of entropy, enthalpy, specific energy, reversibility and irreversibility*
- *Apply the first and second laws of thermodynamics to formulate and solve engineering problems for (i) closed systems, (ii) open systems, and (iii) power cycles*
- *Ability to understand and effectively communicate the fundamentals of thermodynamic analyses and to articulate the basic environmental, economic, and sustainability considerations to the non-thermodynamicist*
- *Use thermodynamic tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems*

1. **Basic Concepts and Definitions:** Introduction and definition of thermodynamics, dimensions and units, microscopic and macroscopic approaches, systems, surroundings and universe, concept of continuum, control system boundary and control surface, properties and state, thermodynamic properties, thermodynamic path, process and cycle, thermodynamic equilibrium, reversibility and irreversibility, quasi static process, energy and its forms, work and heat, gas laws, ideal gas, real gas, law of corresponding states, Dalton's law, Amagat's law, property of mixture of gases, zeroth law of thermodynamics, temperature and its measurement, temperature scale. **[4]**
2. **First Law of Thermodynamics:** Thermodynamic definition of work, thermodynamic processes, calculation of work in various processes and sign convention, non-flow work and flow work, Joule's experiment, first law of analysis for closed system (non- flow processes), analysis of unsteady processes such as filling and evacuation of vessels with and without heat transfer, first law of thermodynamics applied to open systems, steady flow systems and their analysis, steady flow energy equations, boilers, condensers, turbine, compressors, pumps throttling process etc., PMM-I. **[6]**
3. **Second Law of Thermodynamics:** Limitations of first law of thermodynamics, devices converting heat into work, thermal reservoir, heat engines, efficiency, devices converting work into heat, heat pump, refrigerator, coefficient of performance, reversed heat engine, Kelvin Plank statement of second law of thermodynamics, Clausius statement of second law of thermodynamics, equivalence of two statements of second law of thermodynamics, reversible and irreversible processes, Carnot cycle, Carnot engine, Carnot theorem and its corollaries, thermodynamic temperature scale, PMM-II. **[6]**
4. **Entropy:** Clausius inequality, concept of entropy, entropy change in different processes, Tds equation, principle of increase in entropy, T-S diagram, statement of third law of thermodynamics, entropy and disorder, concept of exergy, available and unavailable energy, availability and irreversibility, second law efficiency. **[7]**

5. **Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation**.** **[4]**

6. **Properties of Steam**: Pure substance, property of steam, triple point, critical point, sub-cooled liquid, saturation states, superheated states, phase transformation process of water, graphical representation of pressure, volume and temperature, P-T & P-V diagrams, T-S and H-S diagrams, use of property diagram, steam-Tables &Mollier charts, dryness factor and it's measurement, processes involving steam in closed and open systems. **[6]**

7. **Vapour & Gas Power cycles**: Carnot cycle, Rankine cycle, comparison of Carnot and Rankine cycle, modified Rankine cycle, calculation of cycle efficiencies, variables affecting efficiency of Rankine cycle. Carnot, Otto, Diesel, dual, Atkinson and Brayton cycle. Comparison of Otto, Diesel and dual cycles, calculation of air standard efficiencies, mean effective pressure, brake thermal efficiencies, relative efficiencies of I.C. engine. **[7]**

Outcome(s):

- *Understand the thermodynamics implication and thermodynamics explanation for the states of matter.*
- *Understand and apply basic energy conservation equations for kinetic, potential and flow energies.*
- *Understand the concepts of enthalpy, entropy and the basic laws of thermodynamics.*
- *Understand and solve thermodynamic cycle problems, including the Carnot ideal cycle, the Otto cycle, the Diesel Cycle, Rankine and Brayton*
- *Understand thermodynamic tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems*

Text Books:

1. Nag, P.K, "Engineering Thermodynamics", Tata McGraw-Hill, 5th ed. 2013
2. Cengal Y.A and Boles M.A, "Thermodynamics: An Engineering Approach", McGraw Hill, 7th ed. 2011.

Reference Books:

1. Sonntag, R. E, Borgnakke C and VanWylen G.J, "Fundamentals of Thermodynamics", John Wiley, 7thed. 2009
2. Moran, M. J and Shapiro H. N, "Fundamentals of Engineering Thermodynamics", John Wiley, 6th ed. 2010.

Code ME14.205

Material Science and Metallurgy

Total Lectures: 40
Credit: 3-0-0-3

Prerequisite(s): PY-14.101,CY-14.101

Objective(s):

- *To acquaint students with the basic concepts and properties of Material Science.*
- *To impart the knowledge on mechanical behavior of materials.*
- *To acquire knowledge in various class of materials (like Ferrous, Non-Ferrous Alloys and Advanced Materials) and their applications.*
- *To impart knowledge on Heat Treatment, Microstructure and Phase diagrams.*
- *To acquire knowledge in destructive and non-destructive testing of materials.*

1. **Introduction to Engineering Material & Material Structure:** Development in materials science, introduction to engineering materials classification of material, crystal structures (BCC, FCC and HCP systems), imperfections in crystals - point defects, line defects, surface and bulk defects, slip, twinning. **[5]**
2. **Phase diagrams:** solid solutions, binary alloy system, lever rule, Iron-carbon equilibrium diagram, TTT diagrams**.** **[7]**
3. **Heat Treatment:** Annealing, normalizing, tempering, hardening (case hardening and surface hardening). **[5]**
4. **Ferrous & Non Ferrous Metals:** Allotropy of Iron, types of ferrous metals, alloy steels, tool steels, stainless steels, cast irons, effect of alloying elements on mechanical properties of steel, designation of steels and cast iron. copper and its alloys – properties, brasses, bronzes, copper- nickel alloys, aluminium and their alloys – corrosion resistance, magnesium, titanium, bearing materials. **[7]**
5. **Polymers, Ceramics and Composites:** Mechanical behavior of polymers, crystallization, melting and glass transition, polymer types, polymer synthesis and processing; ceramics – crystal structures and properties, composites - particle reinforced composites, fiber reinforced composites, structural composites, nanoparticle composites. **[6]**
6. **Mechanical Properties and their Testing:** Destructive Testing**-**tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, formability, hardness testing, different hardness tests- Vickers, Rockwell, Brinell, impact test, ductile and brittle fracture, creep, generalized creep behaviour. non-destructive testing (NDT)- visual Inspection, magnetic particle inspection, dye penetrant inspection, ultrasonic inspection, Selection of NDT. **[10]**

Outcome(s):

- *The students will be enhancing their knowledge of materials &their applications.*
- *Students will be able to design the alloy system of ferrous and non-ferrous metals based on their knowledge of phase diagrams and metal characteristics.*
- *The students will also be able to understand the heat treatment processes and destructive and non-destructive testing of materials.*

Text Books:

1. V. Raghavan, "Material Science & Engineering", Prentice Hall India Ltd., Latest Edition.
2. A. K. Bhargava, C.P. Sharma. "Mechanical Behavior & Testing Of Materials", PHI

Learning Private Ltd.

Reference Books:

1. Avner S. H, "Introduction to Physical Metallurgy", Tata-McGraw Hill Publishing Co., New Delhi, Latest Edition.
2. Dieter G. E, "Mechanical Metallurgy", McGraw Hill Publishing Co., New York, Latest Edition.
3. Hajra Choudhury S. K, "Materials Science and Processes", Indian Book Distributing Co., Latest Edition.
4. Material Science and Engineering; I.P. Singh, Subhash Chander; 12th Edition, 2014 Jain Publishers, Delhi.

MA 14.201 **Applied Mathematics** **3-1-0-4**

Total Lecture: 40

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. Linear Programming: Introduction**,** Graphical method (bounded & unbounded solutions); Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). **[12]**

2. Numerical Methods: Solution of system of equations (Gauss elimination and Gauss - Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods). **[10]**

3. Complex Analysis: Function of complex variable, analytic function, Cauchy- Riemann equations(without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues. **[06]**

4. Integral Transform: Laplace transform and inverse Laplace transform First and Second Shifting theorems, Convolution theorem (without proof), Solution of ordinary differential equations with initial conditions by Laplace transforms. Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms. **[12]**

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming , numerical methods ,complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 39th Edition: 2005.
3. Taha H.A., Operation Research: An Introduction, Pearson.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

Code ME14.211

Mechanics of Solids Laboratory

Total Hours: 24
Credit: 0-0-2-1

List of Experiments

1. To determine the Impact toughness (strain energy) through Izod test. **[2]**
2. To determine the Impact toughness (strain energy) through Charpy test. **[2]**
3. To determine the tensile strength of specimen using Universal Testing Machine. **[4]**
4. To find the modulus of rigidity using torsion testing equipment. **[2]**
5. To find the values of bending stresses and Young's modulus of the material of a beam (say a wooden or steel) simply supported at the ends and carrying a concentrated load at the centre using Universal Testing Machine **[2]**
6. To find the shear strength of given specimen using Universal Testing Machine. **[4]**
7. To find the compressive strength of given specimen using Universal Testing Machine. **[4]**
8. To determine the stiffness of the spring and modulus of rigidity of spring wire using spring testing machine. **[4]**

Code ME14.213 **Thermodynamics Laboratory** **Total Hours: 24**
Credit: 0-0-2-1

List of Experiments

1. To measure temperature using different types of measurement devices and compare the measurement methods for accuracy and ease of use. **[10]**

    a. J and K type thermometer
    b. NTC thermistor
    c. PT 100 platinium resistance thermometer (four wire)
    d. 2 x liquid in glass thermometers
    e. Bimetal and gas (vapour) pressure thermometer

2. To measure the humidity using different type of humidity measurement devices and compare the measurement methods for accuracy and ease of use. **[6]**

    a. Hair hygrometer
    b. Wet and dry bulb hygrometer
    c. Whirling hygrometer

3. To study and determine the various properties of steam with steam generator **[8]**

Code ME14.215 **Computer Aided Machine Drawing** **Total Hours: 24**

Credit: 0-0-2-1

1. **Drawing Standards:** Code of practice for engineering drawing, bis specifications–welding symbols, riveted joints, keys, fasteners. reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. **[4]**

2. **2-D Drawings:** Limits, Fits -Tolerancing of individual dimensions, specification of fits, manual preparation of production drawings and reading of part and assembly drawings. **[8]**

3. **CAD Practice:** Drawing, Editing, dimensioning, plotting commands, layering concepts, hatching, detailing, assembly, basic principles of GD&T (geometric dimensioning & tolerancing) **[4]**

4. **Assembly Drawing (using CAD software):** Manual parts drawing and preparation of assembled views given part details for components followed by practicing the same using CAD packages. **[8]**

   Suggested Assemblies: Shaft couplings, plummer block, screw jack, lathe tailstock, universal joint, machine vice, stuffing box, safety valves, non return valves, connecting rod, piston and crank shaft, multi plate clutch. preparation of bill of materials

Text Books:

1. P. S.Gill, 'Machine Drawing', S K Kataria and Sons, 2012.
2. Prof. Sham Tickoo, Sandeep PremDass "Solidworks 2013 for Engineers and Designers" Wiley Publication, 2013.

Reference Books:

1. Randy H. Shih, "Solidworks 2013 and Engineering Graphics: An Integrated Approach", SDC Publications. 2013

ME 14.202 **Kinematics of Machines** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): ME 14.101

Objective(s):

- *To provide basic concept of kinematics and kinetics of machine elements.*
- *Know different machine elements and mechanisms.*
- *Select Suitable Drives and Mechanisms for a particular application.*
- *Develop ability to come up with innovative ideas.*

1. **Basics Of Mechanisms:** Terminology and definitions - degree of freedom mobility, Kutzbach criterion, Grashoff's law, kinematic inversions of 4-bar chain and slider crank chains, mechanical advantage, transmission angle, description of common mechanisms-single, double and offset slider mechanisms, quick return mechanisms, straight line mechanism. **10**

2. **Kinematics:** Displacement, velocity and acceleration analysis in simple mechanisms-Graphical Method of velocity and acceleration analysis for different mechanisms-instantaneous centre of velocity - angular velocity ratio theorem. coriolis acceleration. Three-dimensional kinematics and kinetics of rigid bodies: translation, rotation about a fixed point, general motion, angular momentum, kinetic energy, momentum equation. **10**

3. **Kinematics Of Cam:** Classifications, displacement diagrams, parabolic simple harmonic and cycloidal motions, layout of plate cam profiles, derivatives of follower motion, high speed cams, circular arc and tangent cams, standard cam motion, pressure angle and undercutting. **10**

4. **Gears:** Spur gear terminology and definitions, fundamental law of toothed gearing and involutes gearing, inter changeable gears, gear tooth action, terminology, interference and undercutting , non-standard gear teeth , helical, bevel, worm, rack and pinion gears (basics only), gear trains , parallel axis gear trains, epicyclic gear trains, differentials , automotive transmission gear trains. **10**

Outcome(s):

- *Identify mechanisms and predict their motion*
- *Calculate the degrees of freedom of mechanisms.*
- *Draw velocity and acceleration diagrams of various mechanisms.*
- *Construct CAM profile for the specific follower motion.*
- *Select appropriate power transmission mechanism.*

Text Books:

1. Shigley J. E and Uicker J.J, "Theory of Machines and Mechanisms", McGraw Hill, Inc., Latest Edition.
2. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, Latest Edition.

Reference Books:

1. Thomas B, "Theory of Machines", CBS Publishers and Distributors, Latest Edition.
2. Ghosh A and Mallick A. K, "Thoery of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., New Delhi, Latest Edition.
3. Rao J. S and Dukkipati R.V, "Mechanism and Machine Theory", Wiley-Eastern Limited., New Delhi, Latest Edition.

ME 14.204 **Total Lectures: 40**

Fluid Mechanics

Credit 3-1-0-4

Prerequisite(s): ME 14.101

Objective(s): *This course deals with the understanding of the physical mechanisms and the mathematical models of fluid mechanics. The objectives of the course is to enable the student;*

- *To know properties of fluid.*
- *To calculate hydrostatic forces on submerged surfaces.*
- *To apply Bernoulli equations.*
- *To calculate friction losses in pipes.*
- *To apply conservation of mass, momentum & energy principle.*
- *To apply boundary condition for different conditions.*

1.	**Introduction:** Physical properties of fluids, concept of shear stress, Newtonian and Non-Newtonian fluids	**2**
2.	**Fluid Statics:** Pressure-density-height relationships, manometers, force on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform acceleration and uniform rotation about the axis.	**6**
3.	**Kinematics Of Fluid Flow:** Types of fluid flow, stream lines, streak lines, path lines, stream tubes, stream function and velocity potential, flow nets	**5**
4.	**Dynamics Of Fluid Flow:** Euler's equation of motion along a streamline and its integration, Bernoulli's equation and momentum equation. Boundary Layer Analysis, Boundary Layer Thickness, Boundary Layer over a flat plate.	**5**
5.	**Dimensional Analysis And Hydraulic Similitude:** Dimensional analysis, Buckingham's pi theorem, important dimensionless numbers and their significance, geometric, kinematic and dynamic studies.	**5**
6.	**Flow Past Immersed Bodies:** Lift and drag, expressions for lift and drag	**4**
7.	**Flow Through Pipes:** Laminar and turbulent flow in pipes, general equation for head loss-Darcy-Weisbach and Fanning's equations, Moody's diagram, energy losses through pipe fitting, flow through network of pipes, power transmission through pipelines.	**6**
8.	**Fluid Flow Measurements:** Introduction, venturimeter, orificemeter, Pitot tube, notches and weirs.	**5**
9.	**Introduction To Compressible Flow:** Velocity of sound in a fluid, Mach number, propagation of pressure waves in a compressible fluid	**2**

Outcome(s):

- *An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.*
- *An ability to apply the Bernoulli equation to solve problems in fluid mechanics.*
- *An ability to apply control volume analysis to problems.*
- *An ability to use potential flow theory to solve problems.*
- *An ability to perform dimensional analysis for problems.*
- *Knowledge of laminar and turbulent boundary layer fundamentals.*

Text Books:

1. Som S and Biswas G, "Introduction to Fluid Mechanics and Fluid Machines", 2nd ed., Tata McGraw-Hill, 2007.
2. Douglas J. F, Gasoriek, J. M, Swaffield, J. and Jack, L, "Fluid Mechanics" 5th ed., Pearson Education, 2008

Reference Books:

1. Young D. F, Munson B, Okiishi T. H and Huebsch W. W, "Fundamentals of Fluid Mechanics", 6th ed., John Wiley, 2009.
2. Clayton T. C, Donald F. N, Roberson J. A and Williams B. C, "Engineering Fluid Mechanics", 9th ed., John Wiley, 2008.
3. Cengal Y and Cimbala J, "Fluid Mechanics", 6th ed., Tata McGraw Hill, 2010.

ME 14.206 **Design of Machine Elements - I** **Total Lecture 40**

Credit: 3-0-0-3

Prerequisite(s): ME 14.101, ME 14.201

Objective(s):

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*.

1. **Introduction:** Engineering design - an applied decision theory with respect to functional requirements, aesthetic consideration and ergonomic consideration-traditional design methods-synthesis in design, standardization, preferred numbers, derived series of preferred numbers, types of Fits, tolerance with respect to Indian standard, calculation examples, interchangeability, surface Roughness and its designation on drawing. **4**

2. **Design against Static Load:** Factor of safety, design of simple machine parts, design of Cotter Joint, knuckle Joint and Hooke's Joint, theories of Failures, maximum principal stress theory, maximum shear stress theory, distortion-energy theory of failures. **6**

3. **Design against Fluctuating Load:** Methods to reduce stress concentration. Fluctuating stresses, fatigue failure, endurance limit, low cycle and high cycle fatigue, notch sensitivity, reversed stress-design for finite and infinite life, cumulative damage in fatigue, Soderberg and Goodman lines, modified Goodman's diagram, Gerber equation, fatigue design under combined stresses. **5**

4. **Shaft, Keys and Couplings:** Transmission shafts, shaft design on strength basis, shaft design on torsional rigidity bases, ASME code for shaft design, design of hollow shaft, design of keys, design of couplings- muff coupling, rigid flange coupling, flexible coupling, design of shaft for lateral rigidity, Castigliano's theorem, area moment method. **6**

5. **Welded & Riveted Joints:** Design of riveted joints and simple welded connections under concentric loads only, eccentric load in plane of weld, welded joints subjected to bending moment, Welded joints subjected to torsional moment, welded joints subjected to fluctuating forces. **4**

6. **Threaded Joints:** Basic type of screw fastening, terminology of screw thread, ISO metric screw thread, materials and manufacture, simple analysis of bolted joints, eccentrically loaded bolted joints in shear, eccentric load perpendicular to the axis of the bolt, eccentric load circular base, elastic analysis of bolted joints, bolted joints under fluctuating load. **5**

7. **Power Screw:** Forms of threads, multiple threaded screws, terminology of power screw, torque requirement for lifting of load and for lowering of load, self-locking screw, design of screw jack, differential and compound screws. **4**

8. **Springs:** Types of springs, style of end, stress and deflection equation, series and parallel connections, spring material, design of helical springs, concentric springs, multi-leaf spring, design of load spring. **6**

Outcome(s):

- *Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.*
- *Demonstrate knowledge on basic machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.*
- *Be able to approach a design problem successfully, taking decisions when there is not a unique answer.*

Text Books:

1. Bhandari V. B, "Design of machine elements", Tata McGraw Hill Publication, Latest Edition.
2. Shigley J. E, "Machine Engineering Design", Tata Mc Graw Hill Publication, Latest Edition.

Reference Books:

1. Norton R. L, "Machine design – An Integrated Approach", Tata McGraw Hill Publication, Latest Edition

ME 14.208 **Production Technology-I** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): **ME-14.112**

Objective(s):

- *To analyze and understand the metal cutting phenomenon.*
- *To study the conventional machining processes such as lathe, drilling, milling, shaping.*
- *To select process parameters and tools for obtaining desired machining characteristic.*

1.	**Introduction to Manufacturing Processes:** Introduction to manufacturing, classification of manufacturing processes.	**2**
2.	**Metal Cutting Theory:** Introduction, tool materials, tool geometry, mechanics of metal cutting, tool failures, tool wear in metal cutting, tool life, cutting forces and power, machinability, cutting fluids.	**9**
3.	**Turning Operations:** Introduction, constructional features of a center lathe, cutting tools, operations performed on a center lathe, taper turning methods, thread cutting methods, special attachments, limitations of a center lathe, capstan and turret lathes, turret indexing mechanism, tool layout of turret and capstan machines, automatic lathes, tool layout for automatic lathes, machining time estimation.	**10**
4.	**Hole Making Process:** Introduction, constructional features of a drilling, types of drilling machines, drill geometry, mechanics of drilling process, reaming, boring, tapping, other hole making operations, machining time estimation, boring machine.	**6**
5.	**Milling Process:** Introduction, types of milling machines, constructional features of a milling, cutters, milling operations, dividing head, milling mechanics, machining time estimation, machining center	**9**
6.	**Reciprocating Machine Tools:** Introduction to shaper, planner, slotter and broaching	**4**

Outcome(s): *At the end of the course, the student will be able to understand working of lathe, shaper, planer, drilling, and milling and machines. Comprehend speed and feed mechanisms of machine tools. Estimate machining times for machining operations on machine tools. Be able to select proper metal removing processes for the typical application.*

Text Books:

1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Latest Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", Fourth edition PHI Latest Edition.

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications Gerling, "All About Machine Tools", New Age International (P) Limited, sixteenth edition, 2000.
2. Chapman W. A. J, "Workshop Technology", Volume 1,2,3, CBS Publishers and distributors, Latest Edition.
3. Kalpakjian, S. and Steven R. Schmid , Manufacturing, Engineering & Technology, Pearson.

ME 14.210 **Automobile Engineering** **Total Lectures: 40**
Credit 3-0-0-3

Prerequisite(s): Nil

Objective(s):
- *To identify various automotive systems & subsystems*
- *To explain working & construction of various automotive systems & subsystems.*
- *To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning.*

1. **Introduction** - Introduction of automobile, classification of automobile, parts of an automobile, performance of an automobile, tractive efforts. **4**
   Chassis - Introduction, classification of chassis, frame types & nomenclature of car body.
2. **Fuel Supply, Lubrication and Cooling System -** Fuel feed system in spark ignition engine, types, gravity & pump feed system, layout of spark ignition engine fuel pump system, function of each component. **10**
   Fuel supply system in compression ignition engine, layout, components, function, types, working & line diagram of common rail, individual pump system, fuel injectors, single orifice, multiple orifices.
   Engine friction, lubrication system, areas of heat flow in engines, temperature distribution and temperature profiles, cooling air and water requirements, cooling systems.
3. **Suspension, Wheels and Tyres** - Introduction, Macpherson struts, Ball joint and torsion bars, Electronic ride control and air suspension systems, Sonar shock absorber and active suspension system **10**
   Introduction, Requirement & types of wheels , wheel balancing, wheel alignment
   Introduction, requirements & types of tyre, tyre construction, tyre materials, tyre shape, tread patterns, tyre inflation pressure, causes of wear.
4. **Steering, Gears and Controls -** Purpose, function, general arrangements of steering systems, steering gears, steering ratio, drag link, power steering. **10**
   Clutch- Types, necessity, construction & working, torque-converters.
   Gear Box- Types of gear box, construction & working of constant mesh gear box, synchromesh gear box, propeller shaft & differential,
   Axle- Type of rear axles, front axles & their applications, stub axles
5. **Automotive Electrical & Auxiliary Systems -** Electrical circuit component, symbol and wiring diagrams, battery, starting motor, dynamo, alternators, lighting. **6**
   Auxiliary systems like heating, ventilation and air-conditioning.

Outcome(s):
- *Develop non-working models of automobile sub- systems*
- *Formulate steering, braking and suspension systems*
- *Select a suitable conventional and automatic transmission system*
- *Identify the usage of automotive systems & hybrid vehicles.*

Text Books:
1. William. H. Crouse, (2006), Automotive Mechanics, 10th Edition, McGraw-Hill.
2. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications.

Reference Books:
1. H.M.Sethi, Automotive Technology , Tata McGraw-Hill
2. James E. Duffy, Modern Automotive Technology, Goodheart Willcox Company, 1994

ME 14.212 **Production Technology Laboratory –I** **Total Hours: 24**
Credit: 0-0-2-1

List of Experiments

1.	Study of center lathe machine.	**[2]**
2.	Job – I: Facing, Plain turning, Step turning, External taper turning, External threading, Knurling, Parting off.	**[4]**
3.	Job – II: Facing, Plain turning, Drilling, Boring, Internal threading. Mating with Job I	**[4]**
4.	Study of Shaper	**[2]**
5.	Job – III: To cut multi slots on shaper.	**[2]**
6.	Study of milling machine and calculation of indexing mechanism on Universal Dividing Head.	**[4]**
7.	Job IV: Slotting on milling machine.	**[2]**
8.	Job V: To cut gear teeth on milling machine using dividing head.	**[2]**
9.	Study of radial drilling machine and making of one job with different drilling and reaming operations	**[2]**

ME 14.214 **Fluids Mechanics Laboratory** **Total Hours: 24**
Credit: 0-0-2-1

List of Experiments

1. To Study Bourdon tube pressure gauge. **[2]**

2. To calibrate pressure gage. **[2]**

3. Study of Venturimeter. **[6]**

a. To measure complete static head distribution along a horizontal Venturitube.
b. To compare experimental results with theoretical results.
c. To measure the meter coefficient of discharge at various flow rates.

4. To study discharge over a notch. **[6]**

a. To investigate head against discharge over a notch.

5. To study friction loss in pipe . **[8]**

a. To investigate laminar and turbulent flow in pipe. .
b. To verify Poiseulle's Equation and the coefficient of viscosity for water in the laminar flow region.
c. To demonstrate and measure the change in friction factor from laminar to turbulent.

ME 14.216 **Design of Machine Elements Practice -I** **Total Hours: 24**
Credit: 0-0-2-1

List of Experiments

1.	Design and drawing of a cotter joint, knuckle joint, hooke's joint	**[4]**
2.	Application of theories of failure to design machine members subjected to combined loadings	**[2]**
3.	Design of machine elements against fluctuating loads.	**[2]**
4.	Design and drawing of rigid and flexible couplings.	**[4]**
5.	Design and drawing of a riveted joint & welded joint	**[4]**
6.	Design and drawing of threaded joints.	**[4]**
7.	Design and drawing of power screws.	**[2]**
8.	Design and drawing of springs.	**[2]**

ME 14.301 **Dynamics of Machines** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): ME 14.101, ME 14.202

Objective(s):

- *Understand Kinematics and Dynamics of different machines and mechanisms.*
- *To facilitate students to understand the function of flywheels, the concept of balancing of rotating and reciprocating masses.*
- *To understand the principles in mechanisms used for governing of machines*
- *To give awareness to students on the phenomenon of vibration and its effects.*

1. **Static and Dynamic force analysis:** Constraint and applied forces, static Equilibrium of two and three forces members, principle of virtual work, friction in mechanisms. Dynamic analysis of 4-bar linkage and slider-crank mechanism, velocity and acceleration of a piston, angular velocity and angular acceleration of connecting rod, Engine force analysis, Dynamically equivalent system, inertia of connecting rod, Inertia force in reciprocating engine, crank shaft torque. **[10]**
2. **Engine dynamics and flywheel:** Turning moment diagram of an I. C engine, Fluctuation of crankshaft-speed, flywheel and its effect on cyclic fluctuation of speed of an engine. **[4]**
3. **Balancing:** Static balancing & dynamic balancing, Balancing of several masses, rotating in different planes, Balancing of reciprocating mass, Balancing of in-line engine, Balancing of V-engines, Balancing of radial engines. **[8]**
4. **Governors:** types of governors, analysis of Watt, Porter , Prowell, Hartnell, Hartung governor, Sensitiveness of a governor, hunting, isochronisms and stability of a governor, effect and power of a governor, effect of friction on dynamics of governor. **[8]**
5. **Gyroscope:** Angular velocity, angular acceleration and gyroscopic torque, gyroscopic effect on aeroplanes, naval ships, two wheelers and four wheelers. **[4]**
6. **Mechanical Vibrations:** Types of vibrations, Single degree free & damped vibrations, Logarithmic decrement, Forced vibration of single degree system under harmonic excitation, vibration isolation. **[6]**

Outcome(s):

- *Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines.*
- *Students will demonstrate the dynamics of flywheel and their motion.*
- *Analyse balancing of rotating masses in a single and several planes.*
- *Understand concepts of vibrations in various machineries, their harmful effects and remedies*

Text Books:

1. Shigley J. E and Uicker J. J, "Theory of Machines and Mechanisms", McGraw Hill, Inc., Latest Edition.
2. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, Latest Edition.

Reference Books:

1. Thomas B, "Theory of Machines", CBS Publishers and Distributors, Latest Edition.

2. Ghosh A and Mallick A. K, “Thoery of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., New Delhi, Latest Edition.
3. Bhave S., “Mechanical Vibration”, Pearson India Ltd., Latest Edition

ME14.303 **Design of Machine Elements -II** **Total Lecture 52**
Credit: 4-0-0

Prerequisite(s) ME14.101, ME 14.201, ME 14.206

Objective(s)

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

1. **Design of Gears:** Different types of gears – spur, helical, bevel and worm gears, Beam strength, wear strength, dynamics loads on gears, estimation of module based on beam strength and wear strength, Thermal consideration design of worm gears. **[14]**
2. **Friction Clutches:** Different types of clutches, torque transmitting capacity for multidisc clutches, cone clutches, centrifugal clutches, Friction materials for clutches lining, energy equation and thermal considerations. **[6]**
3. **Brakes:** different types of brakes, Energy equations, Design of block brake, Design of band brake, Design of disc brake, Thermal consideration. **[6]**
4. **Rolling Contact Bearings:** Types of rolling contact bearings, Selection of bearing type, Static load carrying capacity, Equivalent bearing load, Load life relationship, selection of bearing life, Selection of bearing from manufacture's catalogue, Selection of taper roller bearings, Design of cyclic loads and speeds lubrication of bearing contact bearings, Mounting of bearings. **[3]**
5. **Sliding Contact Bearing:** Basic mode of lubrication, Petroff's equation, Mckee's Investigation, Reynold's equation, Raimondi Boyd method, Bearing design-selection of parameters, Bearing materials and construction, selection of lubricant. **[6]**
6. **Miscellaneous Machine Elements:** Engine crank shaft, connecting rod, cylinder head, pressure vessels. **[5]**

Outcome(s)

- *Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.*
- *Demonstrate knowledge on machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.*
- *Be able to approach a design problem successfully, taking decisions when there is not a unique answer.*

Text Books:

1. Bhandari V. B, "Design of machine elements", Tata McGraw Hill Publication, Latest Edition.
2. Shigley J. E, "Machine Engineering Design", Tata Mc Graw Hill Publication, Latest Edition.

Reference Books:

1. Norton R. L, "Machine design – An Integrated Approach", Tata McGraw Hill Publication, Latest Edition

ME 14.305 **Heat and Mass Transfer** **Total Lectures: 40**

3-1-0-4

Prerequisite(s): MA 14.201,ME 14.203, ME 14.204

Objective(s):

- *Identify and understand the various mechanisms of heat and mass transfer that characterize a given physical system.*
- *Formulate models for heat conduction processes. Apply analytical and numerical methods to solve one- and two-dimensional conduction problems.*
- *Analyze and design complex heat transfer applications, such as heat exchangers.*
- *Combine thermodynamics and fluid mechanics principles to analyze heat convection processes.*
- *Integrate radiation aspects into real-world global heat transfer problems.*

1. **Basics Concepts:** Heat transfer in engineering, Mechanisms of heat transfer, temperature field and temperature gradient, conduction, convection and radiation heat transfer, concept of driving potential, combined mechanism of heat transfer. **2**

2. **Fundamental equations of conduction:** General different equation of heat conduction in Cartesian, cylindrical and spherical coordinate system, one dimensional steady state heat conduction, systems without internal heat generation, systems with variable thermal conductivity, composite systems, critical radius of insulation, Special one dimensional steady state situations – **heat generation, pin fins** **6**

3. **Multidimensional steady state conduction:** Introduction, Mathematical analysis of 2-D systems, graphical analysis of 2-D systems, electrical analogy for 2-D systems, Numerical method of solution for 2-D systems, three dimensional systems. **6**

4. **Transient heat conduction:** Introduction, systems with negligible internal resistance – lumped parameter method, systems with negligible surface resistance, heat flow in an infinitely thick plate, systems with finite surface and internal resistance. **5**

5. **Fundamental of convective heat transfer:** Introduction, convective heat transfer coefficient, basic equation, boundary layer concept, laminar heat transfer over flat plate, fully developed heat transfer through smooth pipes, the case of contact heat flux and constant wall temperature boundary condition, dimensional analysis, Correlation of heat transfer in turbulent flow, use of hydraulic diameter, free convection heat transfer phenomena, heat exchangers, Log mean temperature difference, Effectiveness and NTU. **9**

6. **Thermal Radiation:** Basic concept, Theory of thermal radiation, electromagnetic spectrum, Wien's displacement law, Stefan-Boltzmann equation, Concept of black gray bodies without participating media, radiation shields, View factors, Equivalent emissivity of grooved surfaces electrical network analogies. **9**

7. **Mass Transfer**: Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy. **3**

Outcome(s): *Upon successful completion of this course, the student will be able to:*

- *Understand the basic laws of heat transfer.*
- *Analyze problems involving steady state heat conduction in simple geometries.*
- *Develop solutions for transient heat conduction in simple geometries.*
- *Understand the fundamentals of convective heat transfer process.*
- *Evaluate heat transfer coefficients for natural & forced convection.*
- *Analyze heat exchanger performance by using the method of log mean temperature difference.*
- *Analyze heat exchanger performance by using the method of heat exchanger effectiveness.*
- *Calculate radiation heat transfer between black body surfaces.*
- *Calculate radiation heat exchange between gray body surfaces.*

Text Books:

3. Nag P. K, "Heat & mass transfer", TMH, Latest Edition.

4. Holman J. P, "Heat Transfer (in SI units)", TMH, Latest Edition.

Reference Books:

4. Sachdeva R. C, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, Latest Edition.

5. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication

6. Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill

ME 14.307 **Fluid Machinery** **Total Lectures: 40**

Credit 3-0-0-3

Prerequisite(s): ME 14.204

Objective(s): *This course deals with the fluid dynamics and thermodynamics to various kinds of fluid machineries. The objectives of the course is to enable the student;*

- *To impart the knowledge on pumps and turbines.*
- *To understand the basic principles of pneumatics and hydraulics.*
- *To identify pneumatic and hydraulic components and their functions*
- *To understand different types of turbine and its applications.*
- *To compute the efficiency of different types of turbine and pumps.*

1. **Introduction:** Introduction, Application of momentum and momentum equation to flow through hydraulic machinery, Euler's fundamental equation. **[2]**
2. **Impact Of Jet:** Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), effect of inclination of jet with the surface. **[4]**
3. **Hydraulic Turbines:** Classification of turbines, Impulse turbines, constructional details, velocity triangles, power and efficiency calculations, governing of Pelton wheel. **[7]**
4. **Reaction Turbines:** Fransis and Kaplan turbines, constructional details, velocity triangles, power and efficiency calculations, degree of reaction, draft tube, cavitation in turbines, principles of similarity, unit and specific speed, performance characteristics, selection of water turbines. **[7]**
5. **Centrifugal Pumps:** Classifications of centrifugal pumps, vector diagram, work done by impellor, efficiencies of centrifugal pumps, specific speed, model testing, cavitation and separation, performance characteristics. **[7]**
6. **Positive Displacement Pumps:** Reciprocating pump theory, slip and coefficient of discharges, indicator diagram, effect and acceleration, work saved by fitting air vessels, comparison of centrifugal and reciprocating pumps, positive rotary pumps, Gear and Vane pumps, performance characteristics. **[8]**
7. **Other Machines:** Hydraulic accumulator, Intensifier, Hydraulic press, Lift and Cranes, theory of hydraulic coupling and torque converters, performance characteristics, Hydraulic ram, Jet pumps, Airlift pumps. **[5]**

Outcome(s):

- *Able to identify hydraulic problem.*
- *Able to learn any possible improvements on fluid machinery.*
- *Able to compute efficiency of various fluid machineries.*

Text Books:

1. Lal J, "Hydraulic Machines", Metropolitan book co. Pvt Ltd , New Delhi, Latest Edition.
2. Vasandhani V. P, "Hydraulic Machines: Theory & Design", Khanna Pub, Latest Edition

Reference Books:

1. Sayres A. T, "Hydraulic and Compressible Flow Turbomachines", TMH, Latest Edition
2. Sawhney G. S. "Thermal And Hydraulic Machines", PHI, Latest Edition

ME 14.311 **Design of Machine Element Practice II** **0-0-2-1**

List of Experiments

1. To design and draw according to data given Spur Gears. [2]
2. To design and draw according to data given Helical Gears. [2]
3. To design and draw according to data given Bevel Gears. [2]
4. To design and draw according to data given Worm Gears. [2]
5. To design and draw according to data given Friction Clutch. [4]
6. To design and draw according to data given different types of brakes. [4]
7. Selection and drawing of Rolling Contact Bearings. [2]
8. Design of Sliding Contact Bearings. [2]
9. Design and drawing of Crankshaft and Connecting Rod. [4]

ME 14.313 **Fluid Machinery Laboratory** **0-0-2-1**

List of Experiments

1. To study and determine the performance characteristic of a Pelton wheel. [6]

    a. To plot a graph between inlet pressure, flow rate, torque and power against speed for a set of nozzle opening.
    b. To analyze the plotted graph between inlet pressure, flow rate, torque and power against speed for a set of nozzle opening.
    c. To determine the overall conversion efficiency of fluid to mechanical energy, over a range of condition.
    d. To compare experimental results with theoretical results

2. To study and determine the performance characteristics of Francis Turbine [6]

    a. At different flow rates
    b. At different guide vane setting
    c. To determine the overall conversion efficiency of fluid to mechanical energy
    d. To compare experimental results with theoretical results

3. To study and determine the performance characteristics of Centrifugal Pump. [6]

    a. To plot a graph between head v/s flow.
    b. To plot a graph between efficiency v/s flow
    c. To study non dimensional characteristics
    d. To demonstrate Cavitations

4. To study and determine the performance characteristics of Positive displacement pumps [6]

    a. Piston pump
    b. Gear pump
    c. Vane pump
    d. Swash plate pump

ME 14.302 **Computational Methods** **Total Lectures: 40**

Credit-3-0-0-3

Prerequisite(s): Engineering Mathematics

Objective(s):

- *To solve linear systems of equations using Gaussian elimination and Gauss-Seidel iteration.*
- *To use bisection and Newton-Raphson techniques to find approximate roots of non-linear equations, and analyse the errors.*
- *To calculate approximate derivatives and finite integrals;*
- *To apply numerical techniques to solve ordinary differential equations*

1. **Solution of algebraic and transcendental equations:** fixed point iterative methods; method of iteration, order of convergence, method of bisection, regulai-falsi method, Newton-Raphson method. Roots of polynomial equation by Lobachevsky-Graeffe's method, Bairstow's method Solution of system of nonlinear equations by Newton-Raphson's method. [8]
2. **Solution of system of linear algebraic equations:** Direct methods – Gaussian elimination method, Gauss Jordan method, LU decomposition technique (Doolittle's and Crout's method), Cholesky decomposition for symmetric matrices, matrix inversion. Ill conditioned systems – condition index and condition number. Iterative methods – Gauss Seidel method, convergence of the iterative method. [8]
3. **Numerical Integration and Differentiation:** Trapeziodal, Simpson's and Romberg's methods. Degree of precision, Newton Cotes formula, composite forms, Gaussian quadrature using Legendre polynomials. [8]
4. **Curve fitting and interpolation:** Linear regression, Matrix formulation of the least square procedure for linear forms. Weighting for least square method, curve fitting with polynomials, Fourier series and exponential function. Interpolation; curve fitting and interpolation with a cubic spline. [6]
5. **Numerical solution of ODE:** solution of initial value problems by single-step and multi-step methods – Runge-Kuttamethod, Adam-Bashforth-Moulton and Millne's method. Solution of boundary value problem–Finite Difference method. Numerical solution of PDE: methods of finite difference and relaxation technique for solving elliptic and hyperbolic equations. [10]

Outcome(s):

- *Students are able to understand the different numerical methods to solve the algebraic equations and to solve system of linear and nonlinear equations*
- *An ability to apply knowledge of math, science, and engineering to the analysis of heat transfer and fluid mechanics problems.*
- *An ability to identify, formulates, and solves mechanical engineering problems.*
- *An ability to work on multidisciplinary projects*

Text Books:

1. Ghosh P, "Numerical Methods with Computer Programs in C++", PHI, Latest Edition.
2. Grewal B. S, "Numerical Methods in Engineering & Science (Programs in C, C++, Introduction to MATLAB)", Khanna Publishers Latest Edition.

Reference Books:

1. Sastry S. S, "Introductory Methods of Numerical Analysis", PHI Learning Private Limited, Fourth Edition, 2005.

ME 14.304 **I C Engines** **Total Lectures: 40**

Credit 3-1-0-4

Prerequisite(s): ME 14.203, ME 14.204, ME 14.305

Objective(s):

- *To teach students the fundamentals, operations, and performance of internal combustion engines and their different types.*
- *To provide students with the theoretical and experimental ability to operate, analyse, and design internal combustion engines.*
- *To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions*

1. **Introduction to I C Engine:** Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, Stratified charge engine, Scavenging in 2 Stroke engines. **3**
2. **Spark Ignition Engines:** Spark ignition engine mixture requirements, Carburetion, Theory of carburetor, SP and MPFI, Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines. **6**
3. **Compression Ignition Engines:** Combustion in CI engine, Ignition delay, Knock and its control, Combustion chamber design of CI engine, Turbocharging, Supercharging. **6**
4. **Engine Systems and Components:** Ignition systems- Battery, Magneto and Electronic, Lubrication systems, Engine starting system, Engine cooling system, Intake and exhaust system, Drive train- Cam shaft and Valves. **7**
5. **Pollutant Formation Control:** Pollutant, Sources and types, Nox formation, Hydrocarbon emission mechanism, Carbon monoxide formation, Particulate emissions, Effect of pollutant, Emission standards, Catalytic converters and particulate traps, Method of measurement **7**
6. **Alternate Fuels:** Methanol, Ethanol, Hydrogen, Natural gas, Biogas, Bio diesel, Liquefied petroleum gas, Properties, suitability, Engine Modifications, Merits and Demerits. **5**
7. **Performance Characteristic and Testing of I C Engine:** Standards for testing of I.C. Engine, Mean effective pressure, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies, Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance. **6**

Outcome(s): *Upon successful completion of this course, the student will be able to:*

- *Demonstrate a basic understanding of different types of internal combustion engines and their operations.*
- *To analyze the ideal models of engine cycles.*
- *To understand the effect of supercharging and turbocharging on engine performance.*
- *To understand fuel-metering systems: carburetors and fuel injectors, in SI and CI engines.*

Text Books:

1. Ganesan V, "Internal combustion Engines", Tata McGraw Hill Pub. Co. Ltd., 3rd Edition, 2007.
2. Heywood John B, "Internal combustion Engines Fundamentals", McGraw Hill, Latest Edition.

Reference

1. Mathur M. L and Sharma R. P, "Internal Combustion Engines", Dhanpat Rai & Sons, Latest

Books:

Edition.

2. Pulkrabek W. W, “Engineering Fundamentals of the Internal Combustion Engine”, PHI Learning Private Limited, Latest Edition.

ME 14.306 **Production Technology-II** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME-14.205, ME14.112

Objective(s):

- *To understand the basic principles of metal forming, welding and casting processes*
- *To know the various types of melting practices*
- *To broaden the understanding of casting design principles*

1. **Metal Forming:** Nature of plastic deformation, stress-strain relation inelastic and plastic deformation, concept of flow stress, deformation mechanism, hot and cold working, rolling principal, rolling stand arrangement, roll passes, sheet metal working processes bending, bend force, , press work tool and types of dies. **[12]**
   Forging, Extrusion and other Processes: Forging operations, forging design, drop forging die design, die inserts; Extrusion-principle, forward and backward extrusion, impact extrusion, hydrostatic extrusion, extruding tubes Wire drawing- rod and tube drawing, tube making, swaging.
2. **Metal Fabrication Process:** introduction to fabrication process, gas welding and cutting. Electric arc welding-principle of arc, arc welding equipment, electrodes, carbon arc welding, TIG GMAW, SAW, arc cutting Resistance welding: principle –spot, seam, projection, upset, flash welding Other welding process: Thermit welding, electro slag welding, EBW, laser beam welding, forge welding, friction welding, diffusion welding, explosion welding, Welding design: heat input, heat flow, distortion, metallurgy of welding, defects in welding, brazing, braze welding and soldering **[14]**
3. **Metal Casting Process:** Introduction-advantages and limitations-applications-casting termsPatterns: Pattern allowance-pattern materials-types of patterns- colour codes Moulding materials: Moulding sand composition-testing sand properties-sand preparation-moulding sand properties-types of sand moulds-moulding machines Cores: Core sand, types of cores, core prints, chaplets, forces acting on the moulding flasksGating system: Elements of gating system, gates, pouring time, sprue, gating ratio, slagtrap system, risering design-caine's method, modulus method, chills-feeding aids. **[14]**

Outcome(s):

- *Student will be able to*
- *Choose forming techniques for various applications*
- *Develop welding techniques for various alloys*
- *Develop welding application concepts*
- *Develop suitable casting techniques for specific applications*
- *Design of gates and risers in castings*

Text Books:

1.Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Latest Edition.
2.Lindberg Roy A, "Processes and Materials of Manufacture", Fourth edition PHI Latest Edition.

Reference Books:

1. Ostwald P. F, "Manufacturing Processes and Systems", John Wiley and Sons, ninth edition 1998.
2. Kalpakjian, S. and Steven R. Schmid , Manufacturing, Engineering & Technology, Pearson
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications

ME 14.308 **Metrology & Quality Control** **Total Lecture: 40**
Credit: 3-0-0-3

Prerequisite(s) ME 14.215

Objective(s):

- *Describe various instruments and their characteristics.*
- *Solve the problems on angle measurements.*
- *Explain the types of control chart to use, depending on given data.*
- *Solve problems based on quality control and acceptance sampling*.

1. **Introduction to Metrology:** Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements. [4]
2. **Linear and Angular Measurements:** Linear Measuring Instruments – Vernier micrometers, Limit gauges, height and depth gauge as per Indian standards ,Limit gauges – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor ,clinometers, angle gauges, spirit Levels, sine bar – Angle alignment telescope – Autocollimator – Applications. [8]
3. **Form Measurement:** Principles and Methods of straightness – Flatness measurement – Thread measurement, Gear measurement, Interferometry, Types of Interferometer, Flatness, Roundness measurement - Applications. Control Gauges and Comparators. Surface texture measurement with stylus type instruments, Tomlinson surface meter, Talysurf and profilograph. [8]
4. **Advances in Metrology:** Straightness – Alignment, Basic concept of CMM –Types of CMM – Constructional features – Probes – Accessories – Software – Applications –Basic concepts of Machine Vision System – Element – Applications. [4]
5. **Quality Control:** Concept of Quality and quality control, elements of quality & its growth, purpose, setup, policy & objective, factors controlling & quality of design and conformance, balance between cost and quality and value of quality. Specification of quality, planning through trial lots and for essential information [5]
6. **Statistical Quality Control:** Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts (X Bars, R, P. charts) and their constructions and their application. [6]
7. **Acceptance Sampling:** Sampling inspection & percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans. [5]

Outcome(s): *After successful completion of this course the student will be able to:*

- *Make various comparative measurements.*
- *Understand fundamentals of gears, thread measurements and measurements of surface finish.*
- *Control chart techniques in quality control.*
- *Purpose and use of sampling and its benefit*.

Text Books:

1. Metrology and Measurement, Anand Bewoor & Vinay Kulkarni McGraw – Hill
2. Statistical quality Control – Mahajan M., Dhanpat Rai & Sons, Delhi.

Reference Books:

1. Jain R. K, "Engineering Metrology", Khanna Publishers, Latest Edition.
2. Gupta I. C, "Engineering Metrology", Dhanpatrai Publications, Latest Edition
3. Shotbolt, "Metrology for Engineers, McGraw Hill, Latest Edition.
4. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Bester field and Mary Besterfield, "Total Quality Management", 3rd Edition; Pearson Education.
5. Montgomery, Introduction to Statistical Quality Control, John Wiley and Sons (2005).

ME 14.320 **Optimization Methods in Engineering Design** **Total Lectures 40**
Credit 3-1-0-4

Prerequisite(s) ME 14.101

Objective(s)

- *Demonstrate an understanding of how design optimization fits into the overall design process.*
- *Learn how to formulate practical engineering design problems as well-posed optimization problems.*
- *Understanding continuous optimization theory for problem formulation and system modeling*
- *Develop a detailed understanding of numerical methods for optimization through implementation in MATLAB*

1. **Introduction to Design Optimization:** Design Process, conventional v/s optimum design, Optimum design v/s optimal control. [2]

2. **Optimum Design Problem formulation**: The problem formulation process with examples, General Mathematical model for optimum Design. [4]

3. **Graphical Optimization and Basic Concept**: Graphical solution process, Use mathematical and MATLAB for Graphical optimization, Design problem with multiple solutions. [6]

4. **Optimum Design Concepts:** Local and Global minima, Optimality Conditions- Unconstrained problem, Optimality Conditions for functions of single variable and for functions of several variables, Necessary conditions for equality constrained problems, Lagrange multiplies, Necessary condition for a general constrained problem, Karush-kuhn – tucker necessary condition, Global optimality- Convex sets, convex functions, convex programming problems, Engineering design Examples [6]

5. **Numerical Methods for continuous Variable Optimization:** Classification of search methods, simple scaling of variables, Excel solver for unconstrained optimization problems, Excel solver for nonlinear programming, optimum design examples with MATLAB. [5]

6. **Linear programming methods for optimum design:** Linear functions, Standard linear programming problems, optimum solution to L.P. problems, calculation of basic solutions, simplex method, Duality in linear programming, KKT conditions for LP problems. [6]

7. **Numerical method for unconstrained optimum Design:** Gradient- based and Direct search methods, step size determination, Numerical method to determine slip size, search direction determination, other conjugate gradient methods. [6]

8. **Numerical Methods for constrained optimum Design:** Basic concepts, Constrains Status at a design point, Constraint Normalization, The descent function, Linearization of the Constrained problem, sequential linear programming algorithm, Sequential quadratic programming, the constrained steepest descent method. [5]

Outcome(s)

- *Model and formulate optimization problems in standard form and assess the optimality of a solution.*
- *Construct computer programs to determine the optimal solution for unconstrained and constrained nonlinear optimization problems of multiple variables.*
- *Determine the advantages and disadvantages of applying different optimization techniques for a specific problem.*
- *Model and analyze multiobjective and multidisciplinary optimization problems.*

Text Books:

1. Arora, J. S, "Introduction to Optimum Design", McGraw-Hill, Latest Edition.
2. Rao S. S, "Engineering optimization: Theory and practice", John Wiley & Sons Inc, Latest Edition.

Reference Books:

1. Vanderplaats G. N, "Numerical Optimization Techniques for Engineering Design", McGraw-Hill, Latest Edition.
2. Miller, R. E, "Optimization: Foundations and Applications", John Wiley & Sons Inc, Latest Edition.
3. Fletcher R, "Practical Methods of Optimization", Wiley, Latest Edition.
4. Gill P. E, Murray W., & Wright M., "Practical Optimization", Academic Press, Latest Edition.
5. Nocedal J & Wright S. J, "Numerical Optimization", Springer-Verlag Latest Edition.

ME 14.322 **Vibration Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): ME 14.301, MA 14.201

Objective(s):

- *Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.*
- *Perform detailed analysis of the response of one and two degree of freedom systems in both free and forced vibration regimes.*
- *Explain the interaction of mechanical vibrations with humans.*
- *Perform vibration design of simple mechanical systems that can be approximated by one, two, or infinite degree of freedom systems.*

1. **Introduction:** Basic Concept, Classification of vibrations and vibrating systems, Oscillating motion like harmonic motion, periodic motion and vibration terminology. **2**
2. **Free vibration of single degree-of-freedom system:** Vibration model, Equation of motion, natural frequency, viscously damped free vibration, Logarithmic decrement, Coulomb damping. **10**

   Harmonically forced vibration of single degree-of-freedom system: Forced harmonic vibration, vibration isolation, rotating unbalance, whirling of rotating shaft, support motion, Structural damping.
3. **Two Degree Freedom systems:** Introduction, Principal modes, Double pendulum, Torsional system with damping, coupled system, undamped dynamic vibration absorbers **6**
4. **Multi-degree-of-freedom system:** Free vibration of undamped systems, Torsional systems, Co-ordinate coupling and principal Co-ordinates, forced vibration of damp free and damped systems **8**
5. **Numerical technique to find Natural frequencies:** Rayleigh's method, Horzer's method, Matrix Iteration method, energy method. **8**
6. **Vibration analysis of continuous system:** Transverse vibration of strings, longitudinal vibration of rods, Torsional vibration of shafts, transverse vibration of beams. **6**

Outcome(s):

- *Ability to analyze the mathematical model of a linear vibratory system to determine its response.*
- *Ability to solve for the motion and the natural frequency for free and forced vibration of a single degree of freedom damped or undamped system.*
- *Ability to obtain linear mathematical models of real life engineering systems*
- *Ability to solve vibration problems that contain multiple degrees of freedom.*

Text Books:

1. S.Bhave, Mechanical Vibration, Pearson India Ltd., Latest Edition.
2. G. K. Groover, Mechanical Vibrations, Jain Brothers, Roorkee.

Reference Books:

1. S. S. Rao, Mechanical Vibrations, Pearson-Prentice Hall, Latest Edition.
2. T. Thomson, M.D. Dahleh, P. Chandramouli, Theory of vibration with application, PHI Latest Edition.

ME 14.324 **Advanced Metal Casting & Welding** **Total Lectures: 40**

Pre – requisites: *ME 14.306* **Credit: 3-1-0-4**

Objective:

- *To make the students understand the concepts of advance casting technique.*
- *To make the students understand the concepts of advance welding technique.*
- *To make the students understand the principles and operations of special and modern welding processes*

1. **Advanced Casting :** Processes, parameters and applications of Investment Casting, Continuous Casting, Centrifugal casting, Carbon dioxide molding, Shell Moulding, Gravity die/ permanent mold casting, pressure die casting, Resin bonded casting , plaster mold casting, Vaccum Casting, Full Mould Casting, Slush Casting, Non metal Molding /Ceramic Molding. [10]

2. **Inspection and Testing of Casting:** Defects in Casting, its causes and remedies, Inspection and Destructive and nondestructive Testing of Casting including. [4]

3. **Advanced Welding Technique-I:** Electron Beam Welding- Background of the Process, Weld Environment, Welding in Different Degrees of Vacuum, Equipment and Safety, Joint Design, Applications, Laser Beam Welding, Process Parameters, Applications and Limitations. Plasma arc welding: Theory and Principles, Transferred arc and Non-Transferred arc Techniques, Equipment and Tooling, Joint Design Advantages, Disadvantages. [10]

4. **Advanced Welding Technique-II**: Ultrasonic Welding; Propagation of ultrasonic waves in matter, mode of joint formation, joint types and design of product for ultrasonic welding, details of equipment. Friction Welding- Basic Principles, Process Variants, Different Stages of Friction Welding, Mechanism of Bonding, Influence of Process Parameters, Weld Quality and Process Control, Joining of Dissimilar Materials, Advantages, Limitations and Applications. Diffusion Welding- theory and Principle of Process, Key Variables, Intermediate Materials, Deformation Welding, Equipment and Tooling. [10]

5. **Thermal and Metallurgical Consideration.** Thermal considerations for welding, temperature distribution, Analytical analysis, heating & cooling curves. Metallurgical consideration of weld, micro & macro structure. Solidification of weld and properties. [6]

Outcome: *Student will be able to*

- *Develop advanced casting techniques for various alloys*
- *Develop advanced welding techniques*
- *Develop welding application concepts*

Text Books:

1. Khanna O.P., "Foundry Technology", Latest Edition, Dhanpat Rai *Publication*

2. Khanna O.P., "Welding Technology", Latest Edition, Dhanpat Rai *Publication*

3. Howard B Cary, " Modern Welding Technology" Prentice Hall, 2002

Reference Books:

1. Richard L Little, “Welding and Welding Technology” Tata McGraw Hill, 2004.
2. Kalpakjian, S. and Steven R. Schmid , Manufacturing, Engineering & Technology, Pearson
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications

ME 14.326 **Power Plant Engineering** **Total Lectures: 40**

Credit 3-1-0-4

Prerequisite(s): ME 14.203, ME 14.204

Objective(s):

- *Basic knowledge of Different types of Power Plants, site selection criteria of each one of them.*
- *Understanding of Thermal Power Plant Operation, turbine governing, different types of high pressure boilers including supercritical and supercharged boilers, Fluidized bed combustion systems.*
- *Basic knowledge of Different types of Nuclear power plants including Pressurized water reactor, Boiling water reactor, gas cooled reactor, liquid metal fast breeder reactor.*
- *Understanding of Power Plant Economics, Energy Storage including compressed air energy and pumped hydro etc.*
- *Discussing environmental and safety aspects of power plant operation.*

1. **Introduction:** Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion, calculations. Variable Load problem Industrial production and power generation compared, ideal and realized load curves, terms and factors. Effect of variable load on power plant operation, methods of meeting the variable load problem, Power plant economics and selection, Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection. **8**
2. **Steam Power Plant:** General layout of steam power plant. Different systems such as fuel handling system, pulverizes and coal burners, combustion system, draft, ash handling system, feed water treatment and condenser and cooling system, turbine auxiliary systems such as governing, feed heating, reheating flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency. **8**
3. **Hydro Electric Power Plant:** Hydrology: rainfall, runoff, hydrographs, flow duration curves; Site selection for hydro power plants; Classification of hydro power plants; Storage type hydro power plant and its operation; Estimation of power availability; Selection of water turbines; Combination of hydro power plants with steam plants; advantages and disadvantages of hydro power points. **8**
4. **Internal and External Combustion Engine Power Plants:** General layout, performance of diesel engine, Diesel plant operation and efficiency, Gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants. **8**
5. **Nuclear Power Plant:** Basic theory and terminology; Nuclear fission and fusion processes; Fission chain reaction; Moderation; Fertile materials; Nuclear fuels; General components of nuclear reactor; Different types of reactors; Breeder reactors; Nuclear power plants in India; Disposal of nuclear waste. **8**

Outcome(s): *After taking this course the students should be able to:*

- *Select the suitability of site for a power plant.*
- *Calculate performance of thermal power plant.*
- *Propose ash handling, coal handling method in a thermal power plant.*
- *Explain working principle of different types of nuclear power plant.*
- *Calculate load factor, capacity factor, average load and peak load on a power plant.*
- *Indicate safety aspects of power plants.*

Text Books:

1. Nag P. K, “Power Plant Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi, Latest Edition.
2. Yadav R, “Power Plant Engineering”, Central Publishing House, Latest Edition.

Reference Books:

1. El Wakil M. M, “Power Plant Engineering”, McGraw Hill Latest Edition
2. Bernhardt G. A. S & William A. V, “Power station Engineering and Economy”, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, Latest Edition.

ME 14.328 **Turbomachinery** **Total Lectures: 40**

3-1-0-4

Prerequisite(s): 14.204

Objective(s):

- *Teach students how to apply various understandings from other courses;*
- *Provide students with opportunities to apply basic flow equations;*
- *How to compare and chose machines for various operations*.

1. **Introduction:** Basic law and equations, dimensional parameters and their physical significance and specific speed. **5**
2. **Energy Transfer in Turbomachine:** General analysis of a turbomachine, energy transfer between fluid and rotor, degree of reaction. **7**
3. **Centrifugal Fans and Blowers:** Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise. **8**
4. **Centrifugal Compressor:** Construction details, impeller flow losses, slip factor, diffuser analysis, and losses, performance curves. **6**
5. **Axial Flow Compressor:** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems and performance characteristics.[**8**
6. **Axial and radial flow turbines:** Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics. **6**

Outcome(s): *Upon successful completion of this course, the student will be able to:*

- *Classify and explain the function of dimensionless number;*
- *Design Prototype from Model;*
- *Select Fluid Machines for Appropriate Operations;*
- *Applications of Thermodynamics Laws.*

Text Books:

1. Yahya S.H., Turbines, "Compressor and Fans", TMH, Latest Edition.
2. Venkanna B. K., "Fundamentals of Turbomachines", PHI Learning Private Limited, Latest Edition.

Reference Books:

1. Dixon S.I, "Fluid Mechanics and Thermodynamics of Turbomachinery", Pergamon Press, Latest Edition.
2. Shepherd, D.G, "Principles of Turbomachinery", Macmillan, Latest Edition.
3. Mattingly J, "Elements of Propulsion: Gas Turbines and Rockets", Addison-Wesley *Publishing* Company, Latest Edition.
4. Cohen H, Saravanamuttoo H. I. H, Rogers G.F.C., "Gas Turbine Theory", longman, Latest Edition.

ME 14.330 **Robotics** **Total Lecture 40**
Credit 3-1-0-4

Prerequisite(s) EC 14.101

Objective(s)

- *To provide fundamental knowledge of the various sub-disciplines such as kinematics, dynamics, controls, sensors, actuators, etc.*
- *To provide adequate background in both analysis and design of robots.*
- *To provide basic understanding of application of robotics in various applications.*
- *To understand economics behind application of robotics*

1. **Introduction**: Classification of robots, basic robot components, manipulator end effectors, controller, power unit, sensing devices, specification of robot systems, accuracy precision and repeatability. **[5]**
2. **Robot Motion Analysis**: Manipulator Kinematics, Inverse Manipulator Kinematics, Manipulator Dynamics-Newton-Euler and Lagrange formulation, Trajectory generation. **[5]**
3. **Robotic sensing devices**: Position, velocity and acceleration sensors, proximity and range sensors, touch and slip sensors, tactile sensors, force and torque sensors. **[8]**
4. **Robotic vision system**: Imaging components, picture coding, object recognition, training and vision systems, review of existing vision systems. **[8]**
5. **Robotics programming:** Methods of robot programming, types of programming, robotics programming languages, artificial intelligence. **[6]**
6. **Robot applications**: Material transfer and machine loading /unloading, processing applications, welding and painting assembly and inspection, future robotic applications and related technologies developments. **[5]**
7. **Economics analysis of robotics:** Robotics project analysis, life cycle costs, data required for economic analysis, methods of economic analysis. **[3]**

Outcome(s)

- *Be able analyze and design robot for automation purpose.*
- *Be able to understand concept of sensors and actuators. Identify sensors and actuators required for specific applications.*
- *Understand programming principles for robot control.*
- *Implement hardware and software to build a robot that can perform a task.*

TEXT BOOKS:

1. M.P. Groover, M.Weiss, P.N.Nagal, and N.G Odrey, Industrial Robotics, McGraw Hill.
2. K.S. Fu, R.S. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, TMH, Latest edition.

REFERENCE BOOKS:

1. Y.N. Shimon (Editor), hand book of industrial robotics Jhon Wiley and sons.
2. C. Anthony, Mc Donald, Robot Technology, theory, design and applications, Prentice Hall.
3. J. S. Robert, Fundamentals of Robotics Analysis and Control, Prentice Hall, Latest Edition

ME14.310 **Computational Methods Laboratory** **0-0-2-1**

List of Experiments

1. Solving algebraic and transcendental equations using computer programs. [6]
2. Solving a system of linear algebraic equations using direct methods and iterative methods in a computer. [6]
3. Making computer programs on numerical integration and differentiation and some given problems in computer. [4]
4. Developing computer programs for various types of curve fittings and solving a given problem in computer. [4]
5. Developing computer programs for solution of ODE and PDE and solving the same in computer. [4]

ME 14.312 **I.C. Engines Laboratory** **0-0-2-1**

List of Experiments

1. To Study the performance characteristics of single cylinder four stroke petrol engine. [6]

    a. To investigate torque speed and power relationship
    b. To study mean effective pressure
    c. To plot different engine performance curve
    d. To determine volumetric and thermal efficiency

2. To Study the performance characteristics of single cylinder four stroke diesel engine. [6]

    a. To investigate torque speed and power relationship
    b. To study mean effective pressure
    c. To plot different engine performance curve
    d. To determine volumetric and thermal efficiency
    e. To plot a Willans line

3. To Study the performance characteristics of Reciprocating Compressor [6]

    a. To investigate compressor performance with variation in pressure and speed
    b. To determine mechanical, volumetric and isothermal efficiency of compressor
    c. To investigate energy balance and thermodynamics of compressor

4. To Study the performance characteristics of Centrifugal Compressor [6]

    a. To investigate compressor performance with variation in speed.
    b. To investigate non dimensional characteristics.
    c. To compare the performance of centrifugal compressor with ideal system.

ME 14.314 **Production Technology Practice- II** **0-0-2-1**

List of Experiments

1. Study of capstan and turret lathe. [2]
2. Job – I: One component on capstan lathe consisting of various operations. [2]
3. Job – II: One component on turret lathe consisting of various operations [2]
4. Study of surface grinder and centre less grinding machine. [2]
5. Job – III: Surface Grinding. [2]
6. Job – IV: Centre less grinding. [2]
7. Study of Radial Drilling Machine. [2]
8. Job V: To perform different drilling, reaming and boring operations on Radial Drilling Machine. [2]
9. By using lathe tool dynamometer measure the cutting forces in all directions and calculate the following: a) Shear plane angle b) Coefficient of friction c) Power consumption. [4]
10. By using the drill dynamometer, measure the torque and thrust in Drilling operation. [2]
11. Cutting forces measurement during milling using milling dynamometer. [2]

ME 14.316 **Metrology & Quality Control Laboratory** **0-0-2-1**

List of Experiments

1	To measure gaps with help of slip gauges.	**[2]**
2	Measurement of angle/taper using a sine bar.	**[2]**
3	Measurement of chordal thickness of Gear tooth by Gear tooth vernier calliper.	**[2]**
4	Use of three-wire method to determine the effective diameter of external threads.	**[2]**
5	Measurement of flatness and roundness of a given machine/ground/lapped flat and round surface respectively using dial gauge.	**[2]**
6	Measurement of screw thread elements by tool Makers microscope and Inspection of various elements of screw thread by optical projector.	**[4]**
7	To measure surface roughness of a given test piece with the help of surface profilometer or surface roughness tester.	**[2]**
8	Study & Use of Control charts	**[4]**
9	Study of sampling plans.	**[4]**

ME 14.401 **Thermal Engineering System** **Total Lectures: 40**
Credit 3-1-0-4

Prerequisite(s): Engineering Thermodynamics

Objective(s):

Thermodynamics is an essential part of engineering curricula, and has a broad application area such as transportation vehicles, power generation and cooling systems. The course will cover the basic principles of thermodynamics and will give students knowledge about how thermodynamics is applied in engineering practice.

1. **Steam Generator and Draft:** Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc, boiler mountings and accessories; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation. Introduction to high pressure boiler [8]
2. **Steam & Gas Nozzles:** Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. [8]
3. **Steam Turbines:** Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine. [10]
4. **Compressors:** [6]
   Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling.
5. **Steam Condensers:** Component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; Condenser vacuum, sources of air leakage & its disadvantages, vacuum efficiency; calculation of cooling water requirement; air expansion pump. [8]

Outcome(s):

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the analysis of representative fluid and thermal energy components and systems.

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.

Text Books:

1. P.K. Nag , “Basic and Applied Thermodynamics”, Tata Mc Graw Hill Pub
2. Kearton W. J, “Steam Turbine Theory and Practice”, CBS Publisher & Distribution Pvt Ltd, Latest Edition
3. R.K. Rajput, “Thermal Engg.”, Laxmi Publication

Reference Books:

1. Ballaney P. L, “Thermal Engineering”, Khanna Publishers, Latest Edition.
2. Yadav R, “Thermodynamics and Heat Engines”, Central Publishing House, Latest Edition
3. Chattopadhyay P, “ Boiler Operation Engineering”, TMH, 11th Edition, 2008.

ME 14.403 **Refrigeration and Air Conditioning** **Total Lectures: 40**

Credit-3-1-0-4

Prerequisite(s): Engineering Thermodynamics
Heat Transfer

Objective(s): *This course deals with the heating and cooling effects produced in domestic and industrial applications. The objectives of the course is to enable the student;*

- *To understand the principles of refrigeration and air conditioning.*
- *To calculate the cooling load for human comfort & different applications.*
- *To select the right equipment for a particular application.*
- *To understand the effect of temperature and pressure on moist air.*

6. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system. [2]
7. **Air Refrigeration System:** Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems. [4]
8. **Vapor Compression Refrigeration Systems:** Simple Vapour Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. [5]
9. **Multistage Vapor Compression Refrigeration Systems:** Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers. [7]
10. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Steam Jet Refrigerating System. [3]
11. **Refrigerants:** Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics. [3]
12. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. [7]

13. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. [9]

Outcome(s):

Able to understand basic principles of refrigeration.
Able to understand simple and multiple vapour-compression cycle, gas refrigeration cycles and absorption cycles.
Ability to understand the principles of thermal comfort & ventilation
An ability to use refrigerant property tables and psychrometric chart.

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.
2. Arora C. P., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", Wiley Eastern limited, New Delhi, Latest Edition.

ME 14.405 **Total Lectures: 40**

Production Technology III

Pre – requisites: Material Science, Production Technology I **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To exposed to fundamental concept of machining processes like grinding, super-finishing, thread and gear manufacturing.
2. To familiar with rapid prototyping.
3. To understand various non conventional manufacturing processes.

1 **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing. **[7]**

2 **Threads and Gear manufacturing:** Introduction, thread making, thread grinding, thread rolling, Gears types and gear making, machining of gears, gear finishing. **[6]**

3 **Powder Metallurgy:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. **[5]**

4 **Rapid prototyping and Micro Manufacturing:** Introduction, role of rapid prototyping & rapid tooling, features and classifications. Micro & Nano manufacturing processes, fabrication of electronics products and IC. **[6]**

5 **Jigs & Fixtures:** introduction, necessity for jigs & fixtures, elements of fixtures, locators, types of locators, clamping, locating principles. **[4]**

6 **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[12]**

Outcome *The students should be able to:*

1. Apply the knowledge of various advance manufacturing processes.
2. Identify various process parameters and their effect on processes.
3. Figure out application of modernization in machining.
4. Get the knowledge of Jigs and Fixtures so as to utilize machine capability for variety of operations

Text Book

1. Lindberg, "Processes and Materials of Manufacture", Prentice hall India (P) Ltd, Latest Edition.
2. Rao P. N, "Manufacturing Technology", TMH, Latest Edition.
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications.

Reference Book

1. Degarmo, Black and Kosher, "Material and Processes in Manufacturing", Latest Edition.
2. Kempster M. H. A, "Introduction to Jigs and Fixtures Design", Latest Edition.
3. Ghosh A, "Rapid Prototyping", EWP, Latest Edition.

ME 14.407 **Industrial Engineering & Operation Research** **Total Lectures: 40**

Pre – requisites: Knowledge of linear algebra and basic mathematical concepts **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To understand Concept of Industrial Engineering
2. To learn various Industrial Engineering techniques
3. To understand and apply operations research techniques to industrial applications
4. To understand Linear Programming concepts
5. To understand sequencing game theory

1 **Introduction to Industrial Engineering:** Relevance & importance of industrial engineering in industry. Productivity Management*:* Productivity measurement and improvement. [3]

2 **Plant Layout & Material Handling***:* Factors affecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Types of layout Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts, Manual assembly lines, line balancing problems way to improve line balancing. Group Technology, parts family, parts classification and coding, production flow analysis. Introduction to material handling. [12]

3 **Work study & Ergonomics:** Method study, micro - motion study and principles of motion economy. Work measurement: time study, work sampling, standard data, PMTS. Introduction to ergonomics and its scope in relation to work. [7]

4 **Linear Programming**: Introduction to Operation Research, Problem formulation, Simplex methods, primal & dual problem, dual Simplex, sensitivity analysis. Transportation, & Assignment problems, Dynamic Programming. [12]

5 **Decision & Queuing Theory:** Decision under various conditions. Game Theory, Minimax & Maximin strategies. Introduction to Queuing Models. [6]

Outcome: *The students should be able to:*

1. Understand Concept of Industrial engineering and its role in industry.
2. Be good team member and project leaders to carry out projects in companies.
3. Build and solve Linear programming, Transportation models and assignment models.
4. Develop critical thinking and objective analysis decision making.

Text Books:

1. Khanna O P, "Industrial Engineering and Management", Dhanpat Rai Publications, Latest Edition.
2. Monks J. G, "Production/Operations Management", McGraw Hill, Latest Edition.

3. Taha H. A, "Operations Research – An Introduction", Prentice Hall India, Latest Edition

Reference Books:

1. Chitale A. K & Gupta R. C, "Product Design and Manufacturing", McGraw Hill Latest Edition.
2. Sanders M. and Mc Cormic, E., "Human Factors in Engineering", McGraw Hill, Latest Edition.
3. Work Study, ILO, Geneva, Latest Edition.
4. Curie R, "Introduction to Work Study", McGraw Hill, Latest Edition.
5. Philips R & Solberg, "Operations Research", John Wiley, Latest Edition.
6. J K Sharma, Operations Research, Macmillan, 1997

ME 14.415 Mechatronics Total Lecture 40

Credit 3-1-0-4

Prerequisite(s) EC 14.101

Objective(s)

- *To study the definition and elements of mechatronics system.*
- *To learn how to apply the principles of mechatronics for the development of productive and efficient manufacturing systems.*
- *To study the hydraulic and pneumatic systems employed in manufacturing industry.*

1. **Introduction**: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. **[5]**

2. Review of fundamentals of electronics. Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. **[9]**

3. **Drives:** stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer **[6]**

4. **Hydraulic systems**: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. **[8]**

5. **Pneumatics:** production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description **[6]**

6. Description of PID controllers. CNC machines and part programming. Industrial Robotics. **[6]**

Outcome(s)

- *Be able to analyze and design mechatronics system used for automstion.*
- *Demonstrate knowledge on basic electronics used in manufacturing systems.*
- *Be able to design hydraulic systems for automating manufacturing systems.*
- *Be able to design pneumatic systems for automating manufacturing systems.*

Text Books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. J. Musa, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.

Reference Books:

1. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE, 1994.
2. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
3. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005

ME 14.417 **COMPOSITE MATERIALS** **Total Lectures: 40**

Credit 3-1-0-4

Prerequisite Material Science and Metallurgy

Objectives: *To provide a basic understanding of the mechanical and physical properties of polymeric, metallic, and ceramic composites.*
To understand the fundamentals of composite material strength and its mechanical behaviour.
Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
To obtain knowledge and skills needed for the optimum design and manufacture of advanced composite components.

1 **Introduction to Composite Materials:** Introduction, Definition of composite material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites. **[8]**
Reinforcements: Fibres-Glass, Silica, Kevlar, carbon, boron, silicon carbide and boron carbide. Fibres, Particulate composites, Polymer composites, Thermoplastics,
Thermosets, Metal-matrix and ceramic composites

2. **Fabrication of Composites :** Fabrication of Metal Matrix Composites: Commonly used matrices, Basic Requirements in Selection of constituents, solidification processing of composites - XD process, Spray processes - Osprey Process, Rapid solidification processing, Dispersion Processes - Stir-casting & Compocasting, Screw extrusion, Liquid-metal impregnation technique – Squeeze casting, Pressure infiltration, Lanxide process), Synthesis of In situ Composites; Fabrication of Polymer Matrix Composites - Commonly used Matrices Basic Requirements in selection of Constituents, Moulding method, Low pressure closed moulding, pultrusion, Filament winding, Fabrication of ceramic matrix composites - Various techniques of vapour deposition, Liquid phase method and Hot pressing **[8]**

3. **Secondary Processing and Joining of Composite :** Forging and extrusion of composites – critical issues, dynamic recovery and dynamic recrystallization, mechanical properties; Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplastic-graphite composite, Weld bonding, Brazing of MMC **[8]**

4. **Performance of Structural Composites:** Prediction of composite properties, tensile strength of fibre reinforced composites, modulus of elasticity, poission's ratio, density, tribological and thermal properties. Influence of environmental effects such as elevated temperature, moisture etc. on composite properties Laminated plate model, Eshelby's models and Other models. **[8]**
Performance of Composite in Non-structural Applications: Composites in

Electrical, Superconducting and Magnetic Applications, Nano-composite devices.

5. **Characterisation of Composites:** Control of particle/fibre and porosity content, particle/fibre distribution, Interfacial Reaction of matrix-reinforcing component, Coating of reinforcing component, Strength analysis. **[8]**
Industrial Application of Composite Materials : Civil constructions of structures/panels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components etc.

Course outcome:

- *Discuss the benefits and disadvantages of using composites in various structures.*
- *Select the most appropriate manufacturing process for fabricating composite components*
- *Demonstrate understanding of the different materials (fibres, resins, cores) used in composites*
- *Calculate the elastic and strength properties of unidirectional laminates using micromechanics theory*
- *Describe the fracture, fatigue and impact performance of composites*

TEXT BOOKS:

1. Krishan K. Chawla, Composite Materials Science and Engineering, , Springer, 2009
2. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", University Press, India, 2004.

REFERENCES:

1. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-Latest Edition
2. Mallick, P.K., Fiber – Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
3. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
4. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1975.
5. P. M. Ajayan, L.S. Schadler, P. V. Braun, "Nanocomposite Science and Technology", (2003), Wiley-VCH Verlag GmbHCo. KGaA, Weinheim

ME 14.419 **Non Convectional Energy Resources** **Total Lectures: 40**

Credit: 3-1-0

Prerequisite(s): Nil

Objective(s):

- *To familiarize students with the various renewable energy sources.*
- *Awareness of the potential of renewable energy technologies, for sustainability in particular.*
- *Suitable applications of solar, wind, biomass, hydro, geothermal and ocean energy.*
- *Awareness and development of suitable social and economic models with implications.*

1. **Energy Scenario**
   Energy resources in India and worldwide, energy needs and consumption patterns, social and economic implications, global environmental impact, Kyoto protocol, salient features of renewable energy technologies, pollution control and sustainability, Indian govt. policies and Supreme Court directive on renewable energy, subsidies, incentives and other financial implications, ROI., energy audit, energy optimization, green buildings. **10**

2. **Solar Energy Applications**
   Solar thermal systems: Domestic and industrial water heating, green houses, concentrated solar power (CSP), solar refrigeration and air conditioning, solar appliances- cookers, dryers, desalination of water, turbines.
   Solar photovoltaic systems (PV): Solar cell fundamentals, classification, comparison of silicon, thin film, Building Integrated photovoltaic (BIPV) panel technologies, stand alone and grid – integrated systems including storage and other components, economics. **10**

3. **Wind Energy**
   Fundamentals of wind energy, wind power systems- turbines, site selection and economics. grid connected operation, comparison with other renewable systems. **10**

4. **Other Energy Sources**
   Biomass-Conversions and energy content, mini hydro power plant, advantages and economics, geothermal, ocean tidal, wave and thermal energy, fuel cells, hybrid Systems, energy storage, emerging technologies. **10**

Outcome(s):

- *Identify appropriate renewable technology for application.*
- *Assess the economics and ROI.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select ecofriendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:

1. B.H. Khan, "Non-Conventional Energy Resources", Tata McGraw-Hill, Latest Edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publication, First Edition

Reference Books:

1. M. M. El-Wakil, "Power Plant Technology", McGraw-Hill, Latest Edition.

ME 14.421 **Product Design and Development** **Total Lecture 40**
Credit 3-1-0-4

Prerequisite(s)

Objective(s) *This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes.*

1. **Introduction:** Concept of Product, definition and scope, Introduction to product development, Product design and development process, Challenges of product development, Need based developments; Technology based developments, Physical reliability & economic feasibility of design concepts. **[8]**

2. **Needs Identification & Conceptual Design**: Interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance of needs, Generation, selection & embodiment of concept, Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE. Design Optimization **[8]**

3. **Design for Mfg & Assembly:** Methods of designing for Mfg & Assembly. Designs for Maintainability. Designs for Environment. Product costing. Legal factors and social issues. Engineering ethics and issues of society related to design of products **[8]**

4. **Value Engineering/Value Analysis:** Definition. , importance of value, value analysis job plan, creativity,. Case studies. Economic analysis: Qualitative & Quantitative. Material and process selection in value engineering. Concept of Product Life Cycle Management **[8]**

5. **Concurrent Engineering:** Rapid prototyping, Tools for product design–Drafting / Modeling software. CAM Interface. Patents & IP Acts. Overview, Disclosure preparation. **[8]**

Outcome(s) *The student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.*

TEXT BOOKS:

1. Karl T Ulrich, Steven D Eppinger, Product Design & Development. Tata McGrawhill New Delhi 2003.
2. David G Ullman, The Mechanical Design Process. McGrawhill Inc Singapore 1992
3. N J M Roozenberg, J Ekels, N F M Roozenberg, Product Design Fundamentals and Methods. John Willey & Sons 1995

REFERENCE BOOKS:

1. Kevin Otto & Kristin Wood Product Design, Techniques In Reverse Engineering and new Product Development. 1/e 2004, Pearson Education New Delhi.
2. L.D. Miles "Value Engineering."
3. Hollins B & Pugh S, Successful Product Design. Butterworths London.

ME 14.402 Professional Values and Ethics in Engineering Total Lectures 40 3-0-0-3

1. **Introduction:** Definition, objectives and issues in values and ethics, Senses of Engineering Ethics, Moral Autonomy- Koblberg's theory- Gilligan's theory, Professions and Professionalism. [8]

2. **Engineering being Social Experimentation:** Concept of relative values- social, professional and ethical, Codes of Ethics, Industrial standards, A balanced outlook on low, Importance of values and ethics in corporate world. [8]

3. **Strategies and their Formulation:** Importance of value and ethics in conception and formulation of strategy in engineering industries, democratic values, issues in governance and responsibility, safety and risk, risk benefit analysis- some case studies. [8]

4. **Rights and Responsibilities:** An overview of the Indian value system and its application in corporate life partaing to engineering industries. Collegiality and Loyalty, respect for Authority, collective bargaining, Professional rights, Employee rights, Intellectual property rights. [8]

5. **National and International Issues:** Multinational Corporations and business ethics, various care studies pertaining to environment, computer world, social engineering, weapon development, Role of engineering as a managers, consultant, expert witness and moral leader, code of conduct for engineers. [8]

Text book

1. Martin M & Schinzinger, "Roland Ethics in Engineering", McGraw Hill, NY, Latest Edition.
2. Chakraborty S K, "Values and Ethics for Organization Theory and Practice", Oxford India, Latest Edition.

Reference book

1. Govindarajan M G and Natarajan S, "Engineering Ethics", PHI, Latest Edition.
2. Ungar S. H, "Controlling Technology: Ethics and the responsible engineer", NY, Latest Edition.
3. Fleddermann C. D, "Engineering Ethics", Prentice Hall, New Mexico, Latest Edition.

Harris C. E and Pritchard M. S, "Engineering Ethics concepts and cases", Thomson Learning, Latest Edition.

ME 14.404 **CAD/CAM** **Total Lecture 40**
3-0-0

Prerequisite(s) **Mathematics (Matrix), Machine Design, C programming, Machine tool and Machining**

Objective(s)

- Understand the applications and benefits of CAD
- Understand geometric transformation.
- Understand various representations of curves and surfaces.
- Understand the various concepts and characteristics in geometric modeling.
- Understand the basic concepts of CAM. Analyze the components and systems of NC and CNC machine tools. Understand and apply various programming methods for specific jobs.
- Classify various CAPP systems.
- Understand FMS and CIMS with reference to components, advantages and applications.

1. **Fundamentals of CAD**: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU). CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control; Graphics standard: GKS and IGES. **[4]**

2. **Geometric Transformations**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. **[8]**

3. **Representation of curves and surfaces**: Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[6]**

4. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[9]**

5. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[9]**

6. **Computer Aided Process Planning**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. **[2]**

7. **FMS and CIMS**: Flexible Manufacturing System (FMS) and Computer integrated manufacturing system: FMS and its advantages, components of a FMS system. Introduction to CIMS. **[2]**

Outcome(s)

- Understand the capabilities of general Computer Aided Designing Systems and CAD Systems for designing mechanical parts and elements in 2D and 3D dimensions.
- Use effectively CAD / CAM systems in order to produce the final NC code for the manufacturing of various mechanical parts and carry out exchange of data between CAD and CAM systems.
- Describe the principles of various manufacturing processes, manufacturing technology.

TEXT BOOKS:

1. Groover M.P., "Automation, Production Systems and Computer-Integrated Manufacturing", PHI, Latest Edition.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, Latest Edition.

REFERENCE BOOKS:

1. Rao P.N., "CAD/CAM : Principle and Applications", Tata McGraw Hill Publication, Latest Edition

ME 14.406 Operations Management

Total Lectures: 40

Pre – requisites: Elementary knowledge of calculus

Credit 3-1-0-4

Objective: *The course should enable the students :*

1. To understand the strategic significance of Operation management

2. To impart knowledge on Forecasting, Project management, Inventory, Scheduling & capacity planning with appropriate tools and techniques needed for understanding the operational situation.

1 **Manufacturing System:** Introduction to operation management, Types and characteristics of manufacturing systems. [3]

2 **Forecasting Technique:** Use and types of forecasting, Methods of forecasting. Regression analysis [6]

3 **Project Management:** Project management techniques; Introduction to CPM and PERT techniques, network analysis, activities and events, conventions adopted in drawing networks, graphical representation of events and activities. [5]

4 **Materials Planning and Control:** Field and scope, materials planning; Inventories-types and classification; ABC analysis, economic lot size, EOQ model, leads time and reorder point, inventory control systems.
Aggregate planning: definition, aggregate planning methods, Introduction to MRP and MRP-II, Master Production Schedule, Bill of materials. [12]

5 **Operations Scheduling:** Concepts, loading, scheduling and sequencing, single processor scheduling, flow shop scheduling, job shop scheduling, scheduling criteria; Gantt chart. [6]

6 **Capacity Planning:** Definition of capacity, capacity planning, capacity requirement planning, Capacity available and required. [4]

7 **JIT & ERP:** Introduction to the new manufacturing concepts; JIT, lean manufacturing, pull and push systems of production; Kanban system. Introduction to ERP. [4]

Outcome *The students should be able to:*

1. Understand and recognize key issues and problems in Operations Management.

2. Develop an understanding of how Operations Management functions relate to overall organization strategy, effectiveness and performance.

Text Book

1. Monks, J. G, "Operations Management", TMH, Latest Edition.
2. Russel Taylor, "Operations Management"**,** Wiley India.
3. Adam & Ebert, "Productions & Operations Management", PHI, Latest Edition.

Reference Book

1. Buffa W, "Modern Production/Operations Management", Eastern Ltd, Latest Edition.
2. Chary S.N, "Production and Operations Management", TMH, Latest Edition.

ME 14.408 CAD/CAM Laboratory 0-0-2-1

List of Experiments

1. Implement simple programmes for the graphics representation of Transformation and projections. [3]
2. Implement simple programmes for the graphics representation of Conic Sections, cubic splines, and B-splines. [3]
3. Implement simple programmes for the graphics representation of Surfaces- Bilinear, Bicubic surface patch and Bezier surface. [3]
4. Understanding of various CAD commands and creating simple objects. [3]
5. Understanding of holes, cuts and model tree relations. [3]
6. Creation of shafts, rounds, chamfers and slots. [3]
7. Sketch Tools & Datum planes. [3]
8. Creation of objects by revolved features and sweeps. [3]
9. Creation of objects by patterns and copies and blends. [3]
10. Creation of engineering objects in detail using loft feature. [3]
11. Creation of engineering drawing details such as dimensioning, sectional views, adding aesthetics. [3]
12. Assembling of part models using constraints. [3]
13. Assembly operations - part modifications, adding another assembly features display. [3]
14. Generation of GM codes for the given machine part for making the part using CAD software. [3]