Bachelor of Technology Program in Mechanical Engineering

July 2015

Indian Institute of Technology Jodhpur

Bachelor of Technology (B.Tech.) Program in Mechanical Engineering

Curriculum

Cat.	Course Title	L-T-P	Credits	Cat.	Course Title	L-T-P	Credits
I Semester				***II Semester***			
H	ME111 System Exploration-Drawing	3-0-3	4	H	ME121 System Exploration-Workshop	3-0-3	4
H	CS111 Computer Programming	3-1-3	5	H	EE121 Basic Electronics Engineering	3-1-3	5
B	MA111 Linear Algebra and Calculus	4-1-0	5	H	ME122 Engineering Mechanics	3-1-3	5
B	CY211 Chemistry	3-0-3	4	B	MA121 Complex Analysis & Differential Equation	4-1-0	5
C	ME112 Engineering Materials	3-0-3	4	C	ME212 Fluid Mechanics	3-0-3	4
L	HS111 English/ Foreign Language	3-0-0	3	L	*HS121 Rights, Responsibility, Law & Constitution	3-0-0	3
S	*PE111 Physical Exercises I		0	S	*PE121 Physical Exercise II		0
	Total	**33**	**25**		**Total**	**34**	**26**
III Semester				***IV Semester***			
H	*EE221 Basic Electrical Engineering	3-1-3	5	H	*ME221 Manufacturing Technology	3-0-3	4
B	PH111 Electromagnetism and Optics	3-1-3	5	B	MA221 Probability Statistics and Random Processes	4-1-0	5
B	ME211 Thermodynamics	3-1-0	4	C	ME222 Kinematics of Mechanism and Machines	3-0-3	4
C	ME213 Mechatronics	3-0-3	4	C	ME223 Heat and Mass Transfer	3-0-3	4
C	ME214 Mechanics of Solids	3-0-3	4	P	ME298 B.Tech. Project	0-0-9	3
L	*HS211 Economics	3-0-0	3	L	*HS221 Management	3-0-0	3
	Total	**33**	**25**		**Total**	**35**	**23**
V Semester				***VI Semester***			
C	ME311 Dynamics of Machines & Mechanism	3-0-3	4	C	ME321 Refrigeration and Air Conditioning	3-0-3	4
C	ME312 IC Engines	3-0-3	4	C	ME322 Turbomachinery	3-0-3	4
C	ME313 Machining Science	3-0-3	4	C	ME323 Design of Machine Elements	3-0-3	4
C	ME314 Metrology	3-0-3	4	C	ME324 Industrial Engineering	3-0-3	4
P	ME398 B.Tech. Project	0-0-9	3	P	ME399 B.Tech. Project	0-0-9	3
L	*HS311 Psychology	3-0-0	3	L	*HS321 Writing in Newspaper Columns	3-0-0	3
	Total	**36**	**22**		**Total**	**36**	**22**
VII Semester				***VIII Semester***			
E	*Elective 1	3-0-0	3	E	*Elective 4	3-0-0	3
E	*Elective 2	3-0-0	3	E	*Elective 5	3-0-0	3
E	*Elective 3	3-0-0	3	E	*Elective 6	3-0-0	3
P	ME498 B.Tech. Project	0-0-18	6	P	ME499 B.Tech. Project	0-0-18	6
L	*HS411 Leadership	3-0-0	3	L	*HS421 Development of India	3-0-0	3
	Total	**30**	**18**		**Total**	**30**	**18**
					GRAND TOTAL	**267**	**179**

Information yet to be furnished.

S. No.	Category	Course Category Title	Total Courses	Total Credits
1	H	*Hands-on Experience*	7	32
2	B	*Basics*	6	28
3	C	*Compulsory*	14	56
4	E	*Electives*	6	18
5	P	*Hands-On Project*	5	21
6	L	Life Skills	8	24
7	S	*Games & Sports/Social Service*	2	0
		Total	**48**	**179**

I Semester

Course Title	**System Exploration - Drawing**	Course No.	**ME111**
Focus Group	Mechanical Engineering	L-T-P[C]	3-0-3[4]
Offered for	B.Tech	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To inculcate how to expresses ideas of technical nature with a pragmatic intention.
2. To explore from the first idea and intuitive concepts to the final development and evaluation of the quality of a product.
3. Helping students understand the role of engineering graphics in a product design process.

Learning Outcomes

1. To distinguish between the different types of projections, indicate the dimensions and tolerance of technical products, read print, and change drawings according to specific requirements.
2. To visualize, and communicate product design using graphics.
3. To enable, optimize and digitize manufacturing of devices and components through graphic modeling.

Contents

1. Lettering two dimensional geometrical constructions Conics Representation of three-dimensional objects Principles of projections Standard codes Projection of points.
2. Projection of straight lines Projection of planes - Projection of solids Auxiliary projections
3. Spatial geometry for design and analysis-Sections of solids and development of surfaces
4. *Conversion of Projections:* Orthographic projection Isometric projection of regular solids and combination of solids.
5. Pictorial representation-Axonometric projection, Oblique projections and Perspective projections
6. General dimensioning practices, limit dimensioning and cylindrical fits, tolerances of location/form/profile/orientation, designation of surface texture.
7. Plan, Elevation and section of single storied residential (or) office building with flat/ with electrical wiring diagram
8. Fundamental practices of computer aided design and drafting
9. Introduction to AutoCAD/ Solid works Commands, Applied geometry using CAD, Technical Sketching, Editing techniques and commands in CAD
10. Orthographic projection; graphical analysis, Sectional views, Basic dimensioning methods, Primary and secondary auxiliary views in descriptive geometry
11. Definition of point, line, plane, Pictorial drawings, 3D drawings, Solid Modeling,
12. Electronic drawings, typical block diagrams, control circuit layouts, Wiring diagrams, connection layout diagrams, printed circuits.

Reference Books

1. Luzzader, W. J. and Duff, J. M., (2008), *Fundamentals of Engineering Drawing*, Prentice Hall
2. Bhatt, N. D., (2002), *Elementary Engineering Drawing*, Charoter Publishing
3. Bethune, J. D., (2007), *Engineering Graphics with Autocad,* Prentice Hall

Course Title	**Computer Programming**	Course No.	**CS111**
Focus Group	Computer Science and Engineering	L-T-P [C]	3-1-3 [5]
Offered for	B.Tech.	Type	Hands-on Experience for CSE
Pre-requisite		To take effect from	July 2014

Objectives

1. To understand computer programming and its roles in problem solving
2. To understand and develop well-structured programs using C language
3. To learn the basic data structures through implementing in C language

Learning Outcomes

1. Problem solving through computer programming
2. Familiarity of programming environment in Linux operating system
3. Ability to use different memory allocation methods
4. Ability to deal with different input/output methods
5. Ability to use different data structures

Contents

1. Introduction to digital computers, Number systems - binary, octal, hexa, and conversion between the number systems, binary arithmetic
2. Introduction to programming, Problem solving and expression of solution through flow chart and algorithm
3. Parts of a program - primitive data types, variables, operators and their precedence, expressions, input/output, conditionals and branching, looping statements
4. Functions, Storage classes - scope and life time, recursion
5. Arrays, Pointers, User defined data types - structures, unions, Dynamic allocation, File Handling, Linear data structures List, Stack, and Queue, Time and space requirements
6. *Lab:* (i) Understanding Linux working environment, Practicing Linux commands related to file system, file handling, editors, gcc compiler, gdb debugger; (ii) Basic data types, variables, input and output statements; (iii) Conditional and control structures; (iv) Arrays (one and two dimensional); (v) Functions and Recursion; (vi) Structures, Unions and Enumeration; (vii) Pointers; (viii) File handling; (ix) Dynamic memory allocation; (x) Linked Structures

Reference Books

1. Kernighan, B. W. and Ritchie, D. M., *The C Programming Language*, Prentice Hall of India
2. Balaguruswamy, E., *Programming in ANSI C*, Tata McGraw Hill
3. Gottfried, B., *Schaum's Outline of Programming with C*, McGraw Hill
4. Lipschutz, S., *Data Structures, Schaum's Outlines Series*, Tata McGraw Hill
5. Horowitz, E., Sahni, S. and Anderson-Freed, S., *Fundamentals of Data Structures in C*, W. H. Freeman and Company
6. Dromey, R. G., *How to Solve it by Computer*, Prentice-Hall of India

Course Title	**Linear Algebra and Calculus**	Course No.	**MA111**
Focus Group	Mathematics	L-T-P[C]	4-1-0 [5]
Offered for		Type	Compulsory
Pre-requisite		Effect from	July 2014

Objectives

1. To train the undergraduate students towards basic understanding of Mathematics.
2. To provide student with sufficient knowledge in calculus, which can be used by the students in their respective fields.
3. To develop a working knowledge of central ideas of Linear Algebra.

Learning Outcomes

1. Understanding of different structures and their properties like, Dependence, Basis and Dimension.
2. Linear transformations between two structures and its representation by Matrices.
3. Integration in higher dimension and Vector Calculus.

Contents

1. *Linear Algebra:* Fields, Matrices, Elementary Matrices, Row-reduced Echelon Form, System of Linear equations, Vector spaces, Subspaces, Linear Independent set, Basis, Dimension, Direct sum, Quotient spaces, Linear Transformations, Range Space, Null Space, Rank-Nullity Theorem, Algebra of Linear Transformations, Inner product space, Orthogonal sets, Cauchy-Swartz Inequality, Orthonormal sets, Gram-Schmidt Orthogonalization Process. Eigenvalues and eigenvectors of a linear operator, Characteristic polynomials, Minimal polynomial, Cayley-Hamilton theorem, Diagonalization, Singular value Decomposition.
2. Sequences, Series, Power series, Limit, Continuity, Differentiability, chain Rule, Partial Derivatives, Gradient, Directional Derivative, Mean value theorems and applications; Linear Approximation, fundamental theorems of calculus, Newton and Picard method; Taylors theorem, Approximation by polynomials, Bisection method, false position method, fixed point method, Newton-Raphson method, secant method, Critical points, convexity, maxima and minima, Trapezoidal and Simpsons rule, Curve tracing, length, Area, Volume, Double and triple integrals, Differentiability of vector functions, arc length, Curvature, Continuity and Differentiability of vector functions, Vector Calculus, Greens Theorem, Gauss Theorem, Stokes Theorems.

Reference Books

1. Hoffman, K. & Kunze, R., *Linear Algebra*, 2nd Edition, Prentice Hall of India
2. Strang, G. *Linear Algebra and its Applications*, 4th Edition
3. Ghorpade, S. R. & Limaye, B. V., (2006), *A Course in Calculus and Real Analysis,* Springer Verlag
4. Ghorpade, S. R. & Limaye, B. V., (2009), *A Course in Multivarible Calculus and Analysis,* Springer Verlag
5. Thomas, G. B. & Finney, R. L., (1992), *Calculus and Analytic Geometry,* 9th Edition, Addison Wesley Publishing Company

Course Title	**Chemistry**	Course No.	**CY211**
Focus Group	Chemistry	L-T-P[C]	3-0-3[4]
Offered for		Type	Core
Pre-requisite		To take effect from	20 July 2014

Objective

1. This is a course designed to relate the fundamental principles of chemistry with practical problems encountered for engineers. Emphasis will be placed on problem-solving.
2. This course will enable the students to scientific logics of various laboratory safeties and fire in different type of labs. Laboratory will correlate with lecture material.

Learning Outcome

1. Understanding the behavior of matter and materials using fundamental knowledge of their nature
2. Predict potential complications from combining various chemicals or metals in an engineering setting.
3. Maintaining safe laboratory practice while working in lab and otherwise.
4. Keep notebooks of laboratory experiments and be able to evaluate results based on their own notes.

Contents

1. *Thermodynamics of Chemical Processes:* Concept of entropy, Chemical potential, Equilibrium conditions for closed systems, Phase and reaction equilibria, Maxwell relations, Real gas and real solution.
2. Electrochemical Systems: Electrochemical cells and EMF, Applications of EMF measurements: Steady state approximation, Chain reactions, photochemical kinetics
3. Basic Spectroscopy - Fundamentals of Microwave, IR and UV-VIS Spectroscopy: Basic concepts of spectroscopy, Selection rule, Determination of molecular structure.
4. Coordination Chemistry: Coordination numbers, Chelate effect, Coordination complexes and application.
5. Bio-inorganic chemistry: Metal ions in Biological systems, environmental aspects of Metals, NOx, CO, CO_2
6. Organic Reaction Mechanism: Mechanisms of selected organic, bio-organic, polymerization and catalytic reactions.
7. Stereochemistry of Carbon Compounds: Selected Organic Compounds: Natural products and Biomolecules
8. Organic material: polymers, synthetic and natural polymers and their applications
9. *Lab:* (i) Aldol condensation (preparation of tetra phenyl cyclo pentadienone); (ii) Preparation of complex salt of (Co (en) 6) Cl3; (iii) Preparation of double salt crystal of ammonium copper (II) sulphate hexahydrate; (iv) Saponification (Preparation of soap); (v) Preparation of Nylon-6, 6; (vi) To prepare hexamine coblt (III) Chloride (Co (NH_3) 6)Cl3; (vii) Determination of dissolved oxygen in a water by Winklers method; (viii) To use Fourier transform infrared (F. T. I. R) spectroscopy in combination with A. T. R. (Attenuated total reflectance) technique for bio analysis of caffine in tea & coffee and also get IR spectrum of Aldol product and analysis of the spectrum; (ix) To plot the excitation and emission spectrum of curcumin in solvents respectively ethanol and hexaneand find stokes shift by using fluorescence spectroscopy; (x) To determine the

heat capacity, glass trasition temperature and the change in heat capacity for glass transition temperature for polystyrene by using Differential scanning calorimetry (DSC); (xi) To understand the theory and working principle of cyclic voltammetery and to perform CV on ferricyanide solution and to know its electrical properties for example Ep, Ip and diffuse rate etc; (xii) Determine of the Enantiomeric Purity of Naproxen and Ibuprofen; (xiii) A General chemistry laboratory Experiment relating Electron configuration and Magnetic Behaviour.

Reference Books

1. Silberberg, M., *Chemistry: The Molecular Nature of Matter and Change*, 6th Edition, McGraw Hill Education
2. McMurry, J. E. & Fay, R. C., *Chemistry*, 5th Edition, Pearson
3. 3. Hill, R. H. & Finster, D., (2010), *Laboratory Safety for Chemistry Students Laboratory Safety for Chemistry Students,* Wiley

Course Title	**Engineering Materials**	Course No.	**ME112**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objective

To gain an understanding of the relationship between the structure, properties, processing and application of metallic, ceramic, polymeric and electronic materials

Learning Outcomes

1. To understand and apply fundamental scientific and engineering principles to engineering problems in the context of inter-relationship between structure, properties, processing and performance of all classes of materials and material systems.
2. To have the ability to design, conduct, analyze and interpret behavior of materials

Contents

1. *Introduction:* Solid Engineering Materials-their classification and characteristic properties. Structure of solids: crystal systems/lattices, crystal structure, crystallographic planes and directions, interstitial sites, crystallinity in metals, ceramics, semiconductors and polymers. Defects in solids: point, line, planar. Fundamentals of plastic deformation of metals, deformation by slip and twin, plastic deformation in polycrystalline metals, Anisotropy, concept of cold working, preferred orientation, Annealing: Recovery, recrystallization and grain growth; hot working. Phase changes in alloys, Ternary Phase diagrams, Iron and steel making, kinetics of metallurgical reactions
2. Definition, units and common tests conducted to evaluate important engineering properties like physical, chemical, electrical, magnetic, semi/super-conducting, optical, and thermal properties in engineering materials. Microstructure, and properties of different alloys in steel and cast iron, types of cast iron, their microstructures and typical uses. Concept of heat treatments of alloys, annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influence on mechanical properties. Effect of common alloying elements in steel, concept of hardens ability, factors affecting it. Common alloy steels, stainless steel, tool steel, high speed steel, high strength low alloy steel, micro alloyed steel, specifications of steels. Physical metallurgy of common non-ferrous alloys: Cu-, Al- and Ni- based alloys.
3. *Engineering ceramics and polymers:* Structure, properties and application of common engineering ceramics and polymers. Composites: Principle, structure and application of composites, Mechanism of creep, ductile fracture, brittle fracture, fracture toughness, ductile-brittle transition, fatigue fracture, mechanisim of oxidation, corrosion principles, elastic, anelastic and viscoelastic behavior
4. *Laboratory Work*: (i) To investigate creep of a given wire at room temperature; (ii) To Study the Corrosion behavior of metallic materials; (iii) To determine Fiber and void fraction of a glass fiber reinforced composite specimen; (iv) To prepare two metallic specimens for metallographic examination and measure their grain size; (v) To study cooling curve of a binary alloy, (vi) Experiments related to measurement of thermal, electrical, chemical and optical properties of engineering materials

Reference Books

1. Callister, W. D., (1985), *Materials Science and Engineering- An Introduction,* John Wiley & Sons
2. Shackelford, J. F., (1992), *Introduction to Materials Science for Engineers*, Mac Millan Publishing
3. Cottrell, A., (2000), *An Introduction to Metallurgy,* Universities Press
4. Smith, W. F., (2008), *Materials Science and Engineering*, 4th Edition, Tata McGraw Hill
5. Van Vlack, L. H., (2006), *Elements of Material Science and Engineering*, 6th Edition, Pearson Education

Course Title	**English Language and Communication Skills**	Course No.	**HS111**
Focus Group	Humanities and Social Sciences	L-T-P [C]	3-0-0 [3]
Offered for	B. Tech. 1st year	Type	Life Skill
Pre-requisite		To take effect from	July 2014

Objective

1. To enable students to gain competence in English and to use language effectively in a number of contexts.
2. The course focuses on the four basic skills of language learning Reading, Writing, Listening and Speaking and trains the student to employ the above skills in both personal and professional settings.
3. Methodologies that are employed by the instructors include extensive use of audio, visual and print medium, exposes students from diverse backgrounds to both the creative and critical use of language.

Learning Outcomes

1. The course helps students to speak and write better English.
2. The course helps to integrate classroom learning into an everyday communicative activity.
3. Written work and interactive sessions facilitates the students to hone their communication skills in more ways than one.

Contents

1. English is a Crazy Language by Richard Lederer
2. The Snake by D. H. Lawrence
3. Kubla Khan by S. T. Coleridge
4. Short stories of Sherlock Holmes
5. Akeela and the Bee (film)
6. In pursuit of Happiness (film)
7. Trumans Show (film)
8. Invictus (film)
9. Grammar exercises
10. Presentation Skills
11. Public Speaking
12. Group Discussion
13. Language Lab sessions

Reference Books

1. Meenakshi, R. & Sharma, S., (2011), *Technical Communication: Principles and Practice,* Oxford University Press
2. Regional Institute of English, (2006), *English for Engineers,* Cambridge University Press
3. Rizvi, A. M., (2005), *Effective Technical Communication*, Tata McGraw-Hill
4. Rutherford, A. J., (2001), *Basic Communication Skills for Technology,* Pearson

II Semester

Course Title	**System Exploration - Workshop**	Course No.	**ME121**
Focus Group	Mechanical Engineering	L-T-P[C]	3-0-3[4]
Offered for	B.Tech.	Type	Hands-on Experience for CSE, ME, EE, BISS, SS
Pre-requisite		To take effect from	July 2014

Objectives

1. To develop basic knowledge of handling tools in different areas of manufacturing.
2. To provide a practical exposure to the vocational trades within basic practical activities associated with all branches of engineering.
3. To instill confidence to manufacture, assess quality and to perform maintenance or correction in product design.

Learning Outcomes

1. The importance of quality and design of the product with respect to material use, design dimensions and tolerances.
2. Understanding the activities and practical difficulties of skilled workman who ultimately are involved in producing all goods in any industry.
3. Understanding the various aspects of materials.

Contents

1. *Introduction:* Classification of engineering materials and their important mechanical and manufacturing properties, Phase diagrams, Gibbs phase rule, Lever rule, Iron-Iron carbide Phase diagram, T-T-T Diagram, General classification of manufacturing processes, Selection of manufacturing processes, Manufacturing attributes of manufacturing processes. Introduction to bulk property enhancement and surface property enhancement processes.
2. *Casting:* Principles of metal casting (Alloy solidification, homogenous and heterogeneous nucleation, cooling curve, concept of supercooling, grain growth, avrami equation), Patterns, Types of Patterns, Pattern Materials and pattern allowances, Types of Sands, Characteristics of molding sand, Types of cores, Chaplets and chills, their materials and functions, Casting Defects.
3. *Geometric Tolerance design:* Concept of limits fits and tolerances, hole based system, shaft based system, different types of fits
4. *Metal Forming and Sheet metal operations:* Basic Operations and their description (Forging, Rolling, Drawing, Extrusion, Bending, Spinning, Stretching, Embossing and Coining, Die and Punch operation in press work, Shearing, Piercing and blanking, Notching, Lancing.)
5. *Material Removal Processes:* Principles of metal cutting, Introduction to orthogonal and oblique cutting, Chip formation, Cutting tools, their materials and applications, Geometry and nomenclature of single point cutting tool, Tool life, Cutting fluids and their functions, Basic machine tools (Lathe, milling machine, Drilling Machine, Shaper, Planer) and their applications, Introduction to grinding processes. Introduction to non-traditional machining processes (EDM, USM, CHM, ECM, LBM, AJM, and WJM).
6. *Joining Processes:* Fundamentals of Electric arc welding (MMAW, SAW, GMAW, GTAW, PAW) Gas welding and cutting, Resistance welding and Thermit welding, Soldering,

Brazing and Braze welding, Adhesive bonding, Mechanical fastening (Riveting, Screwing, etc.). Plastic Processing: Plastics, their types and manufacturing properties, Introduction to Compression molding, Injection molding and Blow molding, Additives in Plastics. Modern Trends In Manufacturing: Introduction to numerical control (NC) and computerized numerical control (CNC) machines and Rapid Prototyping Techniques

7. *Laboratory Work:* Woodworking (Pattern making exercise), Preparation of aluminum casting, Machining exercise (turning operations), Welding exercise (Preparation of square butt joints, T-joints using arc welding), Sheet metal fabrication (Preparation of tray, funnel, etc.), Fitting exercise and heat treatment of steels, Demonstration on CNC Lathe, CNC Milling. Demonstration on Rapid Prototyping Technique and Electric Discharge Machine.

Reference Books

1. Degarmo, E. P., Kohser, R. A. and Black, J. T., (2008), *Materials and Processes in Manufacturing,* 8th Edition, Prentice Hall of India
2. Kalpakjian, S. and Schmid, S. R., (2006), *Manufacturing Processes for Engineering Materials,* 4th Edition, Dorling Kindersley
3. Chapman W. A. J., (2001), *Workshop Technology* (3 Vols.), 5th Edition, CBS Publishers & Distributors
4. Groover, M. P., (1996), *Fundamentals of Modern Manufacturing*, Prentice Hall International
5. Campbell, J. S., (1999), *Principles of Manufacturing, Materials and Processes*, Tata McGraw Hill Company

Course Title	**Basic Electronics Engineering**	Course No.	**EE121**
Focus Group	Electrical Engineering	L-T-P [C]	3-1-3 [5]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To introduce different components used in electronic circuits and explain their terminal characteristics
2. To teach various methods of electronic circuit analysis and design

Learning Outcomes

1. Ability to do time-domain analysis of electronic circuits for various branch currents and node voltages
2. Ability to appreciate the use of discrete components in designing application specific circuits

Contents

1. *Components and Sources:* Passive components, Resistance, Inductance, Capacitance; lumped element model; series, parallel combinations; Kirchhoffs law: voltage, current, linearity, Voltage and current sources; non ideal sources; representation under assumption of linearity; controlled sources: VCVS, CCVS, VCCS, CCCS; concept of gain, transconductance, transimpedance.
2. *Basic Circuit and Transient Analysis:* Node and loop analysis; Choice of nodes and branches for efficient analysis. Superposition theorm; Thevenin's theorm; Norton's theorem, RL and RC Circuits, Sinusoidal Steady State Analysis, RLC circuits, Time domain response of RL and RC circuits, Two-port Networks and Transfer Function, Sinusoidal steady state response; phasor; impedance; transfer function of two port networks. Frequency response: concept; amplitude and phase response; Bode plots.
3. *Discrete components and Circuits:* Discrete electronic devices: Diode, zener diode, BJT (Bipolar junction transistor), LED, Photodiode, Phototransistor, varactor; characteristics and operation using equivalent circuits, Diode circuits; clipper, clamper circuits. DC power supply: rectifier- half wave, full wave (center tapped, bridge), zener regulated power supply, regulation, BJT biasing; CE-biasing circuits, operating point; large/small signal models of CE-BJT amplifier.
4. *Operational Amplifiers:* Basic model; virtual ground concept; inverting amplifier; non-inverting amplifier, Integrator; differentiator; Basic feedback theory; +ve and -ve feedback; concept of stability; oscillator. Waveform generator for Square wave, triangular wave, Wien bridge oscillator, Schmitt trigger; astable multivibrator, Introduction to active filters, 555 timer: description and data sheet.
5. *Logic gates and Applications:* Numbering system, OR, NOT, AND, NOR and NAND; universal gates; XOR and XNOR gate; Truth tables, Combinational circuits. Designing combinational circuits: SOP, POS form; K-map; Optimization, Multiplexer; Gate base implementation. Logic function representation using truth table, Sequential circuits, flip-flops, S-R flip-flop; JK master slave flip flop; D-flip flop,
6. *Laboratory:* Using Laboratory Instruments; Characterization of Passive Circuit Elements (R, L, C); Time Response of RC and RL Circuits; Frequency Response of RC and RLC Circuits; Equivalent Circuits and Audio Signals; Diode Characteristics and DC Power

Supply; Bipolar Junction Transistor (BJT) Circuits: Inverter and Common Emitter Amplifier; Operational Amplifiers; Basic Combinatorial Circuits; Any new circuit.

Reference Books

1. Smith, R. J. & Dorf, R. C., (2009), *Circuits, Devices and Systems,* 5th Edition, John Wiley
2. Hayt, W. H., Kemmerly, J. E. and Durbin, S. M., (2010), *Engineering Circuit Analysis*, 7th Edition, Tata McGraw Hill
3. Boylestad, R. L. & Nashelsky, L., (2009), *Electronic Devices and Circuit Theory*, 10th Edition, Prentice Hall
4. Sedra, A. S. & Smith, K. C., (2011), *Microelectronic Circuits*, 6th Edition, Oxford University Press

Course Title	**Engineering Mechanics**	Course No.	**ME122**
Focus Group	Physics	L-T-P[C]	3-0-3[4]
Offered for	B.Tech	Type	Basic for CSE, ME, EE, SS, BISS
Pre-requisite		To take effect from	July 2014

Objectives

1. To provide practice to apply knowledge in work, energy and momentum to study rigid body mechanics
2. To educate about the forces and inertia and its effect of motion of rigid bodies.

Learning Outcomes

1. To analyse forces and moments on static rigid body, moments on or between multiple static rigid bodies and internal forces or moment within them
2. To model practical structural problems using concepts of free body diagrams and equilibrium conditions

Contents

1. Basic dimensions in Mechanics, Law of dimensional homogeneity, Vector and Scalar Quantities, Elements of vector algebra. Moment of force about a point/axis, Couple, Moment of Couple about a line. Free Body Diagram, Equations of Equilibrium, Static indeterminacy, Equilibrium in three dimensions Coulomb Fraction, Surface contact friction, Transmission of power through belt. Screw jack, screw thread. Moment of area and centroid, Pappus-Guldinus Theorems, Second moments and product of Area, Transfer theorems, Principal axes. Inertial quantities, Mass-Inertia/Area-Inertia terminology, Translation of coordinate axes.
2. Kinematics of particles, Velocity and acceleration in terms of path variables, simple relative motion, motion of particle relative to a pair of translating axes Newtons laws of rectangular coordinates/rectilinear translation, cylindrical coordinate/Central force motion. Conservation of Mechanical Energy, Work-energy equations, Center of mass based Kinetic energy, Principle of virtual work. Impulse and Momentum relation of particles, Moment of momentum equations-single particle/system of particles Translation/Rotation of rigid bodies, Charles theorem, time derivative of vector for different references. Parallel axis theorems, Rotational Pure rotation of a body of revolution about its axis of revolution/combined with translation. Three dimensional rotation, moment of inertia tensor, relation between angular momentum and torque in three dimensions, Gyroscopic forces. Simple harmonic oscillator, phase and phase difference, phasor diagram, oscillator with constant friction/velocity dependent damping. Forced Oscillations, power adsorption, lightly damped oscillator Motion in non-inertial frames, centrifugal foce, Coriolis force/acceleration, rate of change of vector in inertial and rotating frames.
3. *Experiments:* Vector Analysis with force table; Motion Studies Position Vs time, Velocity Vs Time; Measuring Acceleration due to gravity; Projectile launch; Centripetal motion of Pendulum; Dynamics Atwood Machine; Dynamics experiments with Friction; Sound Waves Frequency analysis;

Reference Books

1. Shames, I., (2003), *Engineering Mechanics*, Prentice Hall
2. Gross, D., Hauger, W. and Schrder J., (2012), *Engineering Mechanics*, Springer
3. Meriam, J. L., Kraige, L. G., (2002), *Engineering Mechanics*, John Wiley & Sons

Course Title	**Complex Analysis and Differential Equations**	Course No.	**MA121**
Focus Group	Mathematics	L-T-P[C]	4-1-0[5]
Offered for		Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. Understanding of fundamentals of complex analysis.
2. Understanding of fundamentals of differential equations.

Learning Outcomes

1. Techniques for differentiation and integration of complex valued functions.
2. Finding analytical and series solution for ordinary and partial differential equations.

Contents

1. Complex numbers, algebra of complex numbers, functions, continuous and analytic functions, Cauchy Riemann Equations, elementary functions, Integral of a complex function, Cauchy-Goursat theorem, Cauchys Integral formula, derivatives of analytic functions, Moreras Theorem, Liouvilles theorem, maximum modulus principle, Taylor series, singularity, types of singularities, Laurant series, Cauchys Residue Theorem, Jordans Lemma, Evaluation of Real integrals.
2. First Order Ordinary Differential Equations, Geometrical interpretation of solution, Solution methods for separable equations, Exact equations, Linear equations, Picards Theorem for IVP, Picards iteration method, Eulers Method, Improved Eulers Method. Second Order Linear differential equations: General solution of homogeneous equation, Existence and uniqueness of solution of IVP, Wronskian and general solution of nonhomogeneous equations, Euler-Cauchy Equation, Extensions of the results to higher order linear differential equations; Power Series Method- application to Legendre equation, Legendre Polynomials, Frobenius Method, Bessel equation, Properties of Bessel functions, Sturm-Liouville BVP, Orthogonal functions, System of first order ODE and its stability, Laplace Transform and Fourier series.
3. Partial Differential equations of first order, solution to pde of first order, Cauchys method for first order pde, Charpits method, Classification of second order equations, characteristics, Riemann Method, uniqueness theorem for hyperbolic equations with given initial and boundary conditions, Dirichlet and Neumann problems, Poisson Integral, Green and Neumanns Function, Heat Equation.

Reference Books

1. Ahlfors, L. A., (2013), *Complex Analysis, 3rd* Edition, Tata McGraw Hill Education
2. Brown, J. W., & Churchill, R. V., *Complex Variables and Applications*, 7th Edition
3. Lang, S., *Complex Analysis*, 4th Edition.
4. Simmons, G. F., *Differential Equations with applications and Historical Notes*, 2nd Edition, Tata McGraw Hill
5. Boyce, W. E. & DiPrima, R. C., *Elementary Differential Equations and Boundary Value Problems,* 10th Edition.
6. Rao, K. S., *Introduction to Partial Differential Equations,* Prentice Hall of India

Course Title	**Fluid Mechanics**	Course No.	**ME212**
Focus Group	Mechanical Engineering	L-T-P [C]	3-1-0 [4]
Offered for		Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objective

1. To inculcate the fundamental properties of fluids.
2. To explain applications of fluid statics, conservation equation in fluid flow and viscous flow.
3. To exemplify concepts of similarity.

Learning Outcomes

1. To evaluate hydrostatic forces on bodies within fluids
2. To apply the fundamental knowledge in modeling and analysis of fluid flow problems in engineering
3. Interpreting data from experiments of fluid flows and solve using differential equations and charts

Contents

1. *Introduction:* Scope of fluid mechanics, continuum approach, definition and types of fluid, differential and integral approaches. (2)
2. *Fluid statics:* Basic equation of fluid statics, hydrostatic force on submerged surfaces. (4)
3. *Integral analysis of fluid flow:* Reynolds transport theorem, conservation of mass, conservation of linear momentum and angular momentum, conservation of energy. (8)
4. *Differential analysis of fluid flow:* Motion of fluid particles, derivation of continuity and Navier-Stokes equations, analytical solutions to fully developed laminar flow problems, introduction to stream function, concept of streamline. (6)
5. *Incompressible inviscid flow:* Concept of inviscid flow, Euler's equation, Bernoulli's equation, velocity potential, Laplaces's equation, superposition of elementary flows. (4)
6. *External incompressible flow:* External versus internal flows, evolution and concept of boundary layer, friction and form drag, definitions of boundary layer thickness, momentum integral equation, concept of adverse pressure gradient and separation, drag coefficients, introduction to streamlining. (5)
7. *Turbulent flow:* Limitations of conventional differential approach, decomposition of instantaneous velocities, time-averaged continuity and Navier-Stokes equations, Reynolds stresses, turbulent viscosity, velocity profile in turbulent pipe flow. (2)
8. *Compressible flow:* Propagation of sound waves, isentropic stagnation properties for flow in ideal gas, basic equations for one dimensional compressible flow, converging-diverging nozzles. (4)
9. *Dimensional analysis and similitude:* Advantages of non-dimensionalization, Buckingham Pi theorem, flow similarity. (2)

Laboratory

Friction in pipes and fittings due to fluid flow (2 experiments); Determination of head loss in pipes having different diameters, different materials and different roughness;

Determination of pressure drop at different types of bends and valves; Wind tunnel (3 experiments); Flow around aero foil and wake profile measurement; Lift and Drag measurement; Tunnel air velocity, velocity profile measurement using Pitot static tube; Flow meter trainer (5 devices); Working principle of different flow meters (orifice plate, venture meter, turbine, Rota meter, electromagnetic flow meter; Measurement and evaluation with reference flow meter (electromagnetic flow meter); Particle image velocimetry (PIV); Flow measurement around an object or blockage using PIV technique; Weather monitoring and Prediction; Measurement of flow, temperature and humidity for understanding and prediction of weather;

Reference Books

1. Fox, R. W., Pitchard, P. J., and McDonald, A. T., (2010), *Introduction to Fluid Mechanics,* 7th Edition, John Wiley & Sons Inc.
2. White, F. M., (2003), *Fluid Mechanics*, 5th Edition, McGraw-Hill

III Semester

Course Title	**Electrical Machines**	Course No.	**EE221**
Focus Group	Electrical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objective

To understand construction, principle of operation, modeling, testing and performance of various electrical machines used in industry

Learning Outcomes

Provide knowledge of principles of operation of different electrical machines. The student will be able to:

1. Model various electrical machines and determine the performance under different loading conditions.
2. Test various machines and pre-determine their performance by the end of the semester.

Contents

1. *Transformers:* Three phase transformers - Equivalent circuit, performance parallel operation-connections-testing-three winding transformers-Auto transformers -Tap-changing-Cooling
2. *Basic concepts of rotating ac machines:* Armature windings-Production of rotating magnetic field in three phase and two phase ac motors-torque development
3. *Induction machines:* Principle- Equivalent circuit-Slip-torque characteristics- Testing of 3-phase Induction motor Circle diagram-harmonic effects-High torque cage motors-Induction generator
4. *Synchronous machines:* Principle-Harmonics in voltage generated-regulation methods-operation with infinite bus-parallel operation-stability-phase swinging-synchronous motor- starting methods- applications testing
5. *Special Machines:* Principle of operation, characteristics and applications of Reluctance motor-shaded pole motor-single phase synchronous motors-ac series motor

Laboratory

1. 3 Phase to 2 Phase conversion using Scott - connection;
2. Parallel Operation of Transformer;
3. Surnphers Test on 3 Phase Transformer;
4. Predetermination of Performance of 3 Phase induction motor using Circle diagram;
5. Load Test on 3 Phase Induction motor;
6. Regulation of Alternator using EMF method;
7. Regulation of Alternator using ZPF method;
8. Parallel Operation of alternator with infinite bus;
9. Slip Test and determination of Xd and Xq;

Reference Books

1. Say, M. G., (1983), *Alternating Current Machines*, Pitman Publishing
2. Langsdorf, A. S., (1999), *Theory of Alternating Machines*, Tata McGraw-Hill
3. Fitzgerald, A. E., Kingsley, C., and Umans, S. D., *Electrical Machinery,* 6th Edition, Tata McGraw-Hill
4. Puchstein, A. F. & Lloyd, T. C., *Alternating Current Machines*, John Wiley & Sons

Course Title	**Electromagnetism and Optics**	Course No.	**PH111**
Focus Group	Physics	L-T-P[C]	3-1-3 [5]
Offered for		Type	Core
Pre-requisite		To take effect from	July 20, 2014

Objectives

To develop an understanding of the foundations of optics and electromagnetism.

Learning Outcomes

The students will be able to relate theoretical concepts with problem solving approach in electrodynamics and optics.

Contents

1. *Electromagnetism*
   - *1.1 Vector Calculus:* Physical interpretation of Gradient, Divergence and Curl, Line, Surface, and Volume integrals.
   - *1.2 Electrostatics:* Coulomb's law, Gauss's theorem, electrostatic potential, Laplace's equation, conductors, capacitors and dielectrics.
   - *1.3 Magnetostatics:* Biot Savart's law, Ampere's law, Lorentz force.
   - *1.4 Magnetic Induction:* Faraday's law, Lenz's law, self and Mutual inductance, energy stored in magnetic field.
   - *1.5 Maxwell's equations:* Displacement current, electromagnetic waves, plane wave solutions of Maxwell's equation, Poynting vector.
2. *Optics*
   - *2.1 Wave Nature of Light: Interference, Fresnel and Fraunhoffer diffraction, ordinary and extraordinary rays, Plane, circular and elliptically polarized light, Birefringence, half wave plates.*

Reference Books

1. Ghatak, A. K., (2007), *Optics*, Tata McGraw Hill
2. Griffiths, D. J., (2005), *Introduction to Electrodynamics*, Prentice Hall of India

Course Title	**Thermodynamics**	Course No.	**ME211**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-0 [4]
Offered for	B.Tech.	Type	Basic for CSE, EE, ME, SS, BISS
Pre-requisite		To take effect from	July 2014

Objectives

1. To use the First Law of Thermodynamics to estimate the potential for thermo-mechanical energy conversion.
2. To recall and comprehend work producing and work consuming cycles.
3. To inculcate the importance of water and steam and change of state.

Learning Outcomes

1. To exemplify how different heat engines work and identify the energy exchange processes.
2. To apply steady flow energy equation to thermodynamic devices.
3. To identify path and non-path based processes and assess their thermodynamic efficiencies.

Contents

1. *Basic concepts:* Thermodynamic system, Properties, State, Process, Thermodynamic equilibrium, Pressure measurement, Zeroth law, Temperature measurement;
2. *Concept of energy and energy transfer in the form of work and heat:* Thermodynamic definition and evaluation of work, Work transfer and its value for different processes, Heattransfer; Equation of state for ideal and real gases, Gas mixtures;
3. *Thermodynamic properties of pure substance:* Phase change process of pure substance and their property diagram, Use of steam table and Mollier diagram;
4. *Energy analysis of closed and open systems:* First law analysis for closed systems undergoing cycle and process, Steady flow energy equation, Flow processes, Throttling process, Joule-Thomson effect, Energy analysis of open systems, Analysis of First law for unsteady flow;
5. *Second law of thermodynamics and Thermodynamic property relations:* Kelvin-Planck and Clausius statement, Heat engine, Heat pump, Refrigerator, Concept of entropy, Entropy principle, Change of entropy for various processes, Introduction to Availability, Concept of Irreversibility, Second law efficiency, Maxwell relations, T-ds relation, Clausius-Clapeyron equation;
6. *Introduction to steam, gas and refrigeration cycles:* Carnot cycle and its limitation, Vapor power cycles (Simple Rankine, Reheatand Regeneration cycles), Gas power cycles (Otto, Diesel, Dual and Brayton cycles), Refrigeration cycles (Vapor compression and Vapor absorption cycles);

Reference Books

1. Moran, M. J. & Shapiro, H. N., (2011), *Fundamentals of Engineering Thermodynamics*, 7th Edition, Wiley
2. Cengel, Y. A. & Boles, M. A., (2010), *Thermodynamics: An Engineering Approach,* McGraw Hill Education
3. Sonntag, R. E. & Wylen, V., (1998), *Fundamentals of Thermodynamics,* Wiley

Course Title	**Mechatronics**	Course No.	**ME213**
Focus Group	Mechanical Engineering	L-T-P [C]	3-1-0 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To expose the learner to the fundamentals of hydraulic and pneumatic power control and their circuits with industrial applications.
2. To explore designing and control of electro-mechanical systems
3. To produce software solution for modern microprocessor based mechatronic systems.

Learning Outcomes

1. Have an appreciation of modern computing technology, and the place that programming has within the Engineering domain.
2. To apply knowledge of control, sensors and actuators on mechansms

Contents

1. Introduction to Mechatronics systems, Mechatronics system components- Measurement Systems, Control Systems, Open and Closed Loops Systems, Sequential Controllers with examples- Water level controller, Shaft speed control, Washing machine control, Automatic camera and Engine management systems.
2. Introduction to sensors and transducers- classifications- Principle and working of Resistive, capacitive, inductive and resonant transducers- optical measurement systems- encoders, photo electric, vision sensor, Fibre optic transducers- solid state sensors and transducers-magnetic measurements, temperature measurements, Chemical measurements- piezoelectric accelerometers - ultrasonic sensors and transducers- flow, distance, velocity measurements.
3. Introduction, Electromagnetic Principles, Solenoids and Relays, Electrical drives -stepper motors, servo motors. Signal processing- Multiplexer, operational amplifier- A/D and D/A converters Introduction to Data acquisition system
4. Programmable logic controller Basic structure- Programming units- Memory- Input - Output Modules- Mnemonics Latching- Timers Internal relays- Counters- Shift Registers- Master and Jump Controls- Programming the PLC using Ladder diagram- Simple example of PLC application.
5. Mechatronics in Engineering Design, Traditional and mechatronics design, Applications - Pick and Place robots, Car park barriers, Bar code reader, Wind screen wiper wing stepper motor control. Case studies - Coin counters, Robot walking machine

Reference Books

1. Bolton, W., (2010), Mechatronics, 4th Edition, Addison Wesley
2. Bradley, D. A., Dawson, D., Burd, N. C. & Loader, A. J., (1993), *Mechatronics*, Chapman and Hall Publications
3. Fraden, J., (2004), *Handbook of Modern Sensors Physics, Designs and Applications,* 3rd Edition, Springer Verlag

Course Title	**Mechanics of Solids**	Course No.	**ME214**
Focus Group	Mechanical Engineering	L-T-P[C]	3-0-3 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 20, 2014

Objectives

1. To inculcate fundamental concepts of stress, strain and deformation of solids
2. Fundamental of applying equilibrium, compatibility and forced deformation relationships to structural elements

Learning Outcomes

1. Apply the fundamentals to analyze determinate and indeterminate structures
2. Physical insight into distribution of stresses and strains in structural members
3. Ability to design structural members using dimensions, force-displacement relationships, boundary conditions, loading and allowable stress

Contents

1. *Concept of stress and strain:* Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; normal strain, shear strain, Hookes law, Poissons ratio,
2. Generalized Hookes law; analysis of axially loaded members.
3. *Torsion:* Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation.
4. *Flexural loading:* Shear and moment in beams; load, shear and moment relationship; shear and moment diagrams; flexure formula; shear stress in beams; differential equation of the elastic curve, deflection of beams.
5. *Transformation of stress and strain:* Transformation of stress and strain, principal stresses, principal strains, Mohrs circle for stress and strain. Combined loading: Axial and torsional; axial and bending; axial, torsional and bending. Column: Buckling of slender columns, Euler bucking load for different end conditions
6. Introduction of theory of elasticity- Analysis of Stress and Strain, Stress equation of equilibrium, Compatibility equations, Stress-Strain Relations, Solution of elasticity equations-stress function approach.
7. Theories of failure- Yield criteria. Energy methods- Generalized forces and displacements, Reciprocal Theorem, Maxwell-Betti-Raleigh reciprocal theorem, Castiglianos theorems, Theorem of virtual work.

Laboratory

Tension Tests, Impact Tests, Hardness Tests, Bending and Torsion Tests, Calibration of Proving Rings, Fatigue Tests, Strain Gage Experiments, Study of Photo-elastic Bench, Calibration of Photo-elastic materials, Wear of Materials.

IV Semester

Course Title	**Manufacturing Technology**	Course No.	**30008**
Focus Group	Mechanical Engineering	L-T-P[C]	3-0-0[4]
Offered for		Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To impart knowledge and train students in area of metal casting and welding processes, by making them familiar with the basic design principles and metallurgical concepts involved and their application.
2. To provide fundamentals of metal forming processes.
3. To impart the knowledge and train the students in the area of machining science and make the students familiar with the various basic principles of machining science, cutting tool materials and its wear mechanisms during the machining operation.

Learning Outcomes

1. Understanding of mechanism of chip formation in machining and grinding processes.
2. Understanding of tool life, role and types of cutting fluids, machinability index and ability to measure tool life, tool wear and flank wear during machining.
3. Understanding of basic design principles involved in Metal casting and understanding of fundamentals of arc welding.
4. Understanding of different non- conventional machining processes

Contents

1. *Conventional Machining Processes:* Metal cutting with single point and multi point cutting tools, selection of machining parameters, Taylors tool life equation, Machinability, factors affecting machinability, tool wear mechanisims, Factors influencing surface quality, dimensional accuracy and material removal rate in machining, Calculation of economic cutting speed, Types of chips, Cutting tool temperature measurement, cutting fluids, cutting forces and power requirements in single point cutting tool merchant circle theory, shear angle relationships, friction and thermal aspects in machining, Nature of cutting with multi-point cutting tools, mechanism of chip formation in drilling and milling, grinding process and its specific features. (Milling cutters and milling machines, Drilling tools and operations, Grinding and other abrasive finishing processes, grinding wheel selection, surface grinding, centreless grinding, Abrasive finishing processes).
2. *Non-Conventional Machining Processes:* Comparison of non-conventional and conventional methods of machining, process parameters, material removal rate and application of electro-discharge machining (EDM), electro-chemical machining (ECM), ultra-sonic machining (USM), electron beam machining (EBM) & laser beam machining (LBM), Abrasive and water jet machining (AJM/ AWJM), Chemical machining.
3. Phase Diagrams, Concept of phase, phase rule, eutectics, Iron-carbon phase diagram, TTT Diagram, Classification of steels. Arc welding fundamentals, welding power sources and power source characteristics. Elementary theory of plasticity, stress/ strain/ strain-rate characteristics of materials, yield criteria of metals, formability, High energy rate forming processes.
4. *Metal Casting Processes:* Sand testing procedures, Machine moulding, cupola furnace,

cupola charge estimation, Design of casting: Sprue design, Riser and Gating system design. Nucleation and grain growth, Segregation, Inspection of castings, casting defects; Shell moulding; investment casting; Hot chamber and cold chamber die casting; centrifugal casting; Powder metallurgy techniques.

5. *Introduction to Computer aided Manufacturing (CAM):* Programmable automation, Numerical control of machine tools. Adaptive control of machine tools CNC design features, Introduction to Manual part programming and computer assisted part programming.

Reference Books

1. Shaw, M. C., (2004), *Metal Cutting Principles,* 2nd Edition, Oxford University Press
2. Benedict, G. F., (1987), *Nontraditional Machining Processes,* CRC Press
3. Heine, R. W., Loper Jr., C. R., and Rosenthal, P. C., (1976), *Principles of Metal Casting,* Tata McGraw Hill
4. Dieter, G. E., (2004), *Mechanical Metallurgy,* 2nd Rev. Edition, McGraw Hill
5. Conner, L. P. (Ed.), (1989), *Welding Handbook: Welding Technology Part-1,* 8th Edition, American Welding Society

Course Title	**Probability, Statistics and Random Processes**	Course No.	**MA221**
Focus Group	Mathematics	L-T-P[C]	4-1-0[5]
Offered for		Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To equip the students with the broad perspective of probability theory.
2. To develop the understanding of various discrete and continuous distributions along with their properties.
3. To understand and differentiate among various statistical and random processes techniques.

Learning Outcomes

1. Ability to analyze and differentiate between deterministic and random environment.
2. Ability to select an appropriate distribution for analyzing data specific to an experiment.
3. Understanding of various statistical and random processes techniques which can be applied to data arising in various applications.

Contents:

1. Introduction to Probability, axioms of probability, Conditional probability, Bayes Theorem, Random Variable, Discrete and Continuous random variables, Distribution Function and Probability Density (Mass) Function, Expectation and Moments of random variables, Moment Generation Function and Characteristic Function, Jointly distributed random variable, Transformation of Random Variables, Special Discrete distributions, Special Continuous distributions, Chebyshevs inequality, Law of large numbers, Central Limit Theorem
2. Regression Analysis, Parameter Estimation, Maximum Likelihood Estimator, Confidence Interval, Hypothesis Testing, Goodness of Fit test
3. Stochastic Processes, Markov Chain, Markov Processes, Queuing models.

Reference Books

1. Ross, S. M., (2012), *Introduction to probability and statistics for engineers and scientists*, Elsevier Science
2. Rohatgi, V. K. & Ehsanes Saleh, A. K. Md., (2011), *An Introduction to Probability and Statistics,* Wiley
3. Johnson, R. A., (2010), *Miller & Freund's Probability and Statistics for Engineers,* PHI Learning
4. Papoulis, A. & Pillai, U. S., (2002) *Probability, Random Variables, and Stochastic Processes,* Tata Mc-Graw Hill

Course Title	**Kinematics of Mechanisms and Machines**	Course No.	**ME222**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To cover the kinematics and dynamics of planar single degree freedom mechanisms
2. To develop skills for designing and analyzing linkages, cams, gears and other mechanisms

Learning Outcomes

1. To understand the implication of computed results in kinematics to improve design of a mechanism
2. To analyze position, velocity and acceleration kinematics of mechanisms

Contents

1. *Kinematics and Mechanism:* Definitions and basic concepts, classification of links, Kinematic pairs, diagram and inversion, mobility, range of movements, Equivalent linkage, and spatial mechanism.
2. *Motion characteristics of Mechanism:* Displacement analysis of plane mechanisms graphical and analytical methods, Plane motion of a rigid body, Instantaneous Centre (IC) of Velocity, Velocity analysis using IC, Velocity and Acceleration Diagrams, Velocity and Acceleration Images, Coriolis component of acceleration
3. *Cam follower mechanism:* Introduction, Comparison with lower pair, Classification of Cam and followers, nomenclature, description and analysis of follower motion, pressure angle, Determine of basic dimensions and synthesis of cam profiles, graphical and analytical methods, Cams with specified contours.
4. Gear and gear train] Spur gears and gear terminology, Fundamental law of gearing, Involute profile, Interference and undercutting, Minimum number of teeth, Contact ratio, Helical gears on parallel shafts, Crossed helical Gears, Bevel helical, Spiral and Worm gears. Simple, compound, epicyclic gear trains, planetary gear trains. Forces, torques and transmitted power in a planetary train, sliding gear boxes and synchronous gear boxes.
5. *Three dimensional Kinematics of rigid body:* Three dimensional kinematics of a particle in term of inertial and non-inertial frame of coordinates, absolute velocity and acceleration of a particle in different system of coordinates, rotational and general motion of a rigid body.

Reference Books

1. Waldron, K. J. & Kinzel, G. L., (2004), *Kinematics, Dynamics and Design of Machinery*, 2nd Edition, Wiley
2. Uicker, J. J., Pennock, G. R. & Shigley, J. E., (2009), *Theory of Machines and Mechanisms,* 3rd Edition, Oxford University Press
3. Ghosh, A. & Mallik, A. K., (2009), *Theory of Mechanisms, and Machines,* 3rd Edition, East West Press
4. Norton, R. L., (2009), *Kinematics and Dynamics of Machinery,* Tata McGraw Hill
5. Bevan, T., (1984), *Theory of Machines*, CBS Publishers and Distributors

Course Title	**Heat and Mass Transfer**	Course No.	**ME223**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objective

To inculcate understanding, formulation, designing and solving problems with concepts in conduction, convection and radiation

Learning Outcomes

1. Analyze empirical situation of steady and transient conduction heat transfer
2. Evaluate transfer coefficients in natural and forced convection in and out of control areas
3. Assess performance of various heat exchangers
4. To solve numerical problems related to conduction and radiation heat transfer

Contents

1. *Introduction and basics of to heat transfer:* Modes of heat transfer, Fouriers law, conductivity, diffusivity
2. *Heat conduction equation:* 1D Heat conduction, General heat conduction equation, Boundary and initial conditions, Heat generation
3. *Steady heat conduction:* Heat conduction in plane wall, cylinder, sphere, network analysis, critical radius of insulation, heat transfer from fins
4. *Transient heat conduction:* Lumped system analysis, transient heat conduction in large plane walls, long cylinders and sphere with spatial effect, Heisler and Grober charts
5. *Numerical methods of heat conduction:* Finite difference formulation, numerical methods for 1D and 2D steady state heat conduction, 2D steady state shape factor method.
6. *Introduction to convection:* Fundamentals, Velocity and thermal boundary layer, laminar, turbulent flows, conservation equations for mass, momentum and energy, solution of boundary layer equations, Analogy between heat and momentum transfer, Non-dimensional numbers
7. *External heat transfer:* Drag and heat transfer, parallel flow over flat plates, flow across cylinders and spheres
8. *Internal heat transfer:*
9. *Natural/free convection:*
10. *Boiling and condensation:*
11. *Heat Exchangers*
12. *Introduction to radiation:*
13. *View factors:*
14. *Mass Transfer:*

Laboratory

Fundamentals of temperature measurement; Evaluation of different temperature measurement devices, such as Pt100, NTC and k type thermocouples, bimetallic thermometer, gas pressure thermometer, and mercury thermometer with phase transition temperatures of water at 0^{o}C with ice water and at 100^{o}C with boiling water under STP; Testing and measurement using resistance thermometers; Calibration of k-type

thermocouple; Conduction in solids, Determination of thermal conductivity of a given specimen (metal) considering both linear and radial conduction; Solar water heater demonstration, Demonstration of domestic solar water heating system using halogen lamp as light source; Estimation and measurement of thermal energy storage with water as storage medium; Free and forced convection (evaluation of convective heat transfer coefficient), Heat transfer during free and forced convection over flat plate, plate fins and pin fin bundle; Estimation of convective heat transfer coefficient cross checking with Nusselt number Reynolds number correlations; Heat exchangers design evaluation, Parallel flow Heat exchanger, Counter flow heat exchanger, Cross flow heat exchanger; Laws of radiation, Lamberts distance law, Lamberts direction law; Stefan Boltzmanns law; Kirchhoffs law; Investigation of the wavelength of light;

Reference Books

1. Incropera, F. P. & Dewitt, D. P., (2011), *Fundamental of Heat and Mass Transfer*, John Wiley & Sons
2. Cengel, Y. A. & Ghajar, A. J., (2008), *Heat and Mass Transfer*, McGraw Hill
3. Holman, J. P., (2001), Heat Transfer, McGraw Hill

V Semester

Course Title	**Dynamics of Machines and Mechanisms**	Course No.	**ME311**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objective

1. To teach students concepts of planar, inverse, Newtonian dynamic analysis of mechanisms and machines
2. To inculcate concepts of generalized forces and principle of virtual work
3. To exemplify concepts of static and dynamic mass balancing and flywheels
4. To teach linear vibration analysis of one and two degree of freedom rigid body systems

Learning Outcome

1. Identify and distinguish basic and advanced mechanisms in the study and control of motion
2. Evaluation of forces and torques in mechanism and machines in operation
3. To perform static and dynamic balance of simple mechanisms

Contents

1. *Dynamic force Analysis and Engine Dynamics:* Inertia and D Alembert Principle, the principle of superposition, shaking forces and moment, flywheel, Multi-cylinder engine designs,
2. *Dynamics of Rigid bodies:* Kinetics of system of particles, linear momentum and moment of momentum, equations of motion and their first integrals, Kinetics of rigid body, linear and angular momentum, kinetic energy, equations of motion, Dynamics lumped-parameter models of mechanical systems
3. *Dynamics of Cam and Governors:* Rigid and elastic body cam system, effect of sliding friction, analysis of Cam with reciprocating follower, kinetostatic force analysis of Cam follower, analysis of elastic Cam systems, Types of Governors, Characteristics of Governor, approximate analysis of speed load characteristics of an engine
4. *Balancing:* Static unbalance, static balancing machines, dynamics balancing, balancing of a single and multi-cylinder engines, balancing multi-cylinder reciprocating engines, balancing of linkage, and balancing of Machines
5. *Vibration Analysis:* Introduction, Basic features of vibratory systems, single degree freedom systems, system with two degree freedom, continuous systems, and vibration measurement systems.

Reference Books

1. Uicker, J. J., Pennock, G. R. and Shigley, J. E., (2009), *Theory of Machines and Mechanisms,* 3rd Edition, Oxford University Press
2. Ghosh, A. & Mallik, A. K., (2009), *Theory of Mechanisms, and Machines,* 3rd Edition, East West Press
3. Norton, R. L., (2009), *Kinematics and Dynamics of Machinery,* Tata McGraw Hill
4. Thomson, W. T., *Theory of Vibrations with Applications,* CBS Publishers & Distributors
5. Meirovitch, L., *Elements of Vibration Analysis*, McGraw-Hill International Editions

Course Title	**IC Engines**	Course No.	**ME312**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objective

To create an understanding about the different internal combustion engines and the measurement of its operational characteristics.

Learning Outcomes

1. Application of thermo, fluids, heat transfer to analyse the operation and performance of IC engines
2. Gain experience in component design and system matching such as turbo chargers

Contents

Introduction Engine classification

1. Engine Design and Operating Parameters Engine geometry; Brake Performance; Indicated Performance; Friction Relationships among performance parameters; Tests of operating Characteristics.
2. Combustion Thermodynamics Air and Fuels Combustion Stoichiometry Dissociation Equilibrium combustion products; Practical chemical equilibrium; First law analysis of closed reacting systems; Heating value and enthalpy of formation; Adiabatic flame temperature; First law analysis of open reacting systems; Combustion efficiency
3. Thermodynamic Properties of Engine Working Fluids Working fluids for engine processes Ideal gas mixtures; Tables for species properties; Curve fits for species properties; Computer routines for properties and composition
4. Fuel/Air Cycle Analysis Fuel/air cycle computer simulation; Fuel/air cycle results: efficiency and performance; Comparison with actual cycles; Deviation from Ideal Cycle Behavior
5. Ideal Properties Models of Engine Processes and Cycles Constant volume (Otto), Constant pressure (Diesel), Limited pressure (Dual), Comparisons of ideal cycle results, Ideal intake/exhaust processes, Open Cycle calculation with residuals
6. Spark-Ignition Engine Combustion Features of process Flame structure and propagation Factors affecting burning rate; Abnormal combustion and knock Combustion chamber design
7. Diesel Engine Combustion Features of diesel combustion process; Ignition delay; Knock in diesel engines
8. SI and Diesel Engine Emissions Nature and extent of problem; Nitrogen oxides; Carbon monoxide; Hydrocarbons Particulates Emissions control strategies.
9. IC Engines: The Future Engine development prospects; Stratified charge; direct injection systems; Homogeneous charge; compression ignition; Low temperature diesel combustion; Advanced electronic-controlled engines; Hybrids and fuel cells

Reference Books

1. Heywood, J. B., (2004), *Internal Combustion Engine Fundamentals*, MIT Press
2. Taylor, C. F., (1985), *The Internal Combustion Engine in Theory and Practice: Vol. 1* & 2, 3rd Edition, MIT Press
3. Pulkrabek, W. W., (1999), *Engineering Fundamentals of the Internal Combustion Engine*, 2nd Edition, Prentice Hall

Course Title	**Machining Science**	Course No.	**ME313**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

To impart the knowledge and train the students in the area of machining science and make the students familiar with the various basic principles of machining science, cutting tool materials and its wear mechanisms during the machining operation.

Learning Outcomes

1. Understanding of mechanism of chip formation and ability to measure cutting forces during chip formation.
2. Understanding of economics of machining, heat distribution in machining and its effects and ability to carry out temperature measurement during machining.
3. Understanding of tool life, role and types of cutting fluids, machinability index and ability to measure tool life, tool wear and flank wear during machining.
4. Understanding of different grinding processes, grinding wheel selection, temperature and force measurement during grinding.
5. Understanding of different non- conventional machining processes and ability to measure Tool wear rate and Material Removal Rate.

Contents

1. *Introduction:* Basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting-force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shaffer theories-critical comparison. -System of tool nomenclature and conversion of rake angles-nomenclature of multi point tools like drills, milling-conventional Vs climb milling, mean cross sectional area of chip in milling-specific cutting pressure.
2. *Heat distribution in machining:* Effects of various parameters on cutting temperature-methods of cutting temperature measurement in machining--cutting fluids. Essential requirements of tool materials-development in tool materials-ISO specification for inserts and tool holders-tool life-conventional and accelerated tool life tests-concept of machinability index-economics of machining. Grinding and other abrasive finishing processes, grinding wheel selection, surface grinding, centreless grinding, Abrasive finishing processes)
3. *Wear Mechanisms and Chatter in machining:* Measuring Techniques Reasons for failure of cutting tools and forms of wear-mechanisms of wear-chatter in machining-factors effecting chatter in machining-types of chatter-mechanism of chatter.
4. *Non Conventional Machining Processes:* Comparison of non-conventional and conventional methods of machining, process parameters, material removal rate and application of electro-discharge machining (EDM), electro-chemical machining (ECM), ultra-sonic machining (USM), electron beam machining (EBM) & laser beam machining (LBM), Abrasive and water jet machining (AJM/ AWJM), Chemical machining.
5. *Jigs Fixtures: P*rinciples of design of jigs and fixtures
6. *Laboratory Work:* Cutting force measurement in turning operation using 6 component

dynamometer; Cutting tool temperature measurement experiment; Tool wear measurement using taylor tool life equation; Effect of processes parameters on tool wear rate and material removal rate in EDM; experiment on surface roughness measurement during machining processes; measurement of grinding ratio and temperature rise during grinding

Reference Books

1. Shaw, M. C. (1984) *Metal Cutting Principles*, Oxford Claredon press
2. Boothroyd, G. & Knight, W. A., (1989), *Fundamentals of Machining and Machine Tools*, Marcel Dekker
3. El-Hofy, H. A., (2006), *Fundamentals of Machining Processes: Conventional and Nonconventional Processes*, CRC Press
4. Benedict, G. F., (2008), Introduction to Nontraditional Machining Processes, ASM International

Course Title	**Metrology**	Course No.	**ME314**
Focus Group	Mechanical Engineering	L-T-P [C]	3-1-0 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To appraise the students about the error that they can observe when measuring surface characteristics such as roughness, flatness, straightness and other parameters, measurements such as diameters, angularity and circularity,
2. To teach how to perform the measurement and sampling of parameters such as pressure, temperature etc.

Learning Outcomes

1. To identify errors and measurement of dimensions using noncontact techniques
2. To develop skills for using measurement devices such as interferometer, coordinate measurement, and optical flats
3. To evaluate the process capability and perform statistical sampling of data

Contents

1. Types of errors, design of limit gauges and various comparative measurement; Fundamentals of gears, thread measurements and measurements of surface finish; Non contact measurement techniques using optical methods and vision Techniques; Coordinate metrology and Form; Measurement Use of control charts and acceptance sampling in SQC.
2. *Basic Concepts:* Legal Metrology – Precision - Accuracy - Types of errors least square fit. Linear and Angular Measurements- Standards of Measurements - Calibration - Interchangeability and selective assembly - Gauges for inspection types - Gauge design - Taylor's principle - Introduction to Comparators - Types of Comparators - Mechanical, Mechanical - Optical, Electrical and Electronic, pneumatic- flow type-differential pressure type.
3. *Internal and External screw threads:* Measurements of various elements of thread - Best size wire - Two and three wire method. Gear: Measurements of various elements - Constant chord method - Base tangent method. Surface Finish: Surface topography definitions - Measurement of Surface Texture - Methods - Evaluation of Surface finish.
4. *Optical Metrology and Non Contact Measurement Techniques:* Principle of light wave interference - Light sources Measurement with optical flats- Types of Interferometers - Michelson, Twyman Green Specialisation of Michelson, NPL flatness Interferometers, The Pitter NPL gauge laser interferometer - laser micrometer - surface roughness measurement using laser. Machine vision - Image processing techniques - edge detection -feature extraction applications.
5. *Coordinate Measuring Machine:* components of CMM-types-measuring head - types of probe- alignment error-causes of error -measuring accuracy-calibration of CMM-performance of CMM-applications-measurement integration, Measurement of straightness - Flatness - squareness - parallelism - circularity roundness and runout.
6. *Control Charts & Acceptance Sampling:* Introduction - Definition of Quality - Chance Causes and assignable Causes SQC Benefits and Limitations-Theory of Control Charts: Control Charts for Variables - R, - charts - run up - run down - Process capability studies.

Control Charts for attributes P chart, nP chart, C and U chart. acceptance sampling- OC curve - AQL - LTPD - AOQL - Sampling Plans - Simple - Double - Multiple and sequential sampling plans simple problems

Reference Books

1. Jain, R. K., (2012), *Engineering Metrology*, Khanna Publishers
2. Gupta, R. C., (1994), *Statistical Quality Control*, Khanna Publishers

Course Title	**B. Tech. Project**	Course No.	**ME398**
Focus Group	Mechanical Engineering	L-T-P [C]	0-0-9 [3]
Offered for	5^{th} to 8^{th} Semester	Type	Compulsory
Pre-requisite		To take effect from	July, 2014

Objectives

1. To gain hands on experience on innovative technology project
2. To prepare the students to solve/work on the real world/practical/theoretical problems involving issues in computer science and engineering

Learning Outcomes

1. Ability to design and model a system
2. Ability to plan and execute well defined objective
3. Ability to work in team at component level and system level
4. Ability to troubleshoot
5. Ability to reuse- or integrate with- existing components
6. Ability to derive performance metrics and assess quantitatively the performance of system
7. Ability to report and present the findings in standard formats

VI Semester

Course Title	**Refrigeration and Air Conditioning**	Course No.	**ME321**
Focus Group	Mechanical Engineering	L-T-P [C]	3-1-0 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

To study the characteristics and engineering design of heating, ventilating, air conditioning and refrigeration and to enable the students to achieve effective and efficient design solutions.

Learning Outcomes

1. The students will learn to explain and analyze the refrigeration systems, their various components, and to apply them in real system analysis.
2. They will demonstrate the knowledge of basic principles of refrigeration cycle and psychometry.

Contents

1. *Introduction:* Definition, Necessity, Methods of refrigeration, Coefficient of performance (COP), Fundamentals of air-conditioning systems, Refrigerants - Definition, Classification, Nomenclature, Desirable properties, Comparative study, Introduction to eco-friendly Refrigerants;
2. *Air Refrigeration Systems:* Carnot refrigeration cycle, Brayton refrigeration or the Bell Coleman air refrigeration cycle, Air craft refrigeration system, Simple cooling and simple evaporative types, Regenerative type, Comparison of different systems;
3. *Vapour Compression (VC) Refrigeration Systems:* Simple VCrefrigeration system - Limitations of reversed Carnot cycle with vapor as the refrigerant, Analysis of VC cycle considering degrees of sub cooling and super heating, Effects of operating conditions on COP, Comparison of VC cycle with air refrigeration cycle, Multistage refrigeration systems - Necessity of compound 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;
4. *Other Refrigeration Systems:* Vapour Absorption Refrigeration System Basic Systems, Actual COP of the system, Performance, Relative merits and demerits, Electrolux refrigeration, Steam jet refrigerating system - Introduction, Analysis, Relative merits and demerits, Performance applications, Cascade refrigerating systems Necessity, Selection of pairs of refrigerants for the system, Concept of cascade temperature, Analysis, Multi staging, Comparison with VC systems, Applications;
5. *Psychometry of Air & Air Conditioning Processes:* Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Wet bulb temperature, Thermodynamics wet bulb temperature, Psychometric chart, Psychometry of air-conditioning processes, Mixing process, Basic processes in conditioning of air;
6. *Air-Conditioning Load Calculations:* Outside and inside design conditions, Sources of heating and cooling load, Heat transfer through structure, Solar radiation, Electrical applications, Infiltration and ventilation, Heat generation inside conditioned space, Apparatus selection, Comfort chart;

7. *Air Conditioning Systems with Controls & Accessories:* Classifications, Layout of plants, Equipment selection, Air distribution system, Duct system design, Filters, Refrigerant piping, Design of summer air-conditioning and Winter air conditioning systems, Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls, Accessories;
8. *Refrigeration and Air Conditioning Equipments:* Type of compressors and their performance curves, Types of condensers, Heat transfer in condensers, Types of expansion devices, Types of evaporators, Cooling and dehumidifying coils;

Reference Books

1. Jordan, R. C. & Priester, G. B., (2003), *Refrigeration & Air conditioning,* Prentice Hall of India
2. Arora, C. P., (2008), *Refrigeration & Air conditioning,* Tata McGraw Hill
3. Stocker, W. F. & Jones, J. W., (2000), Refrigeration & Air conditioning, Tata McGraw Hill
4. Prasad, M., (1999), *Refrigeration & Air conditioning*, Wiley Eastern Limited
5. Arora, C. P. & Domkundwar, S., (1985), *A course in Refrigeration & Air Conditioning,* Dhanpat Rai & Sons

Course Title	**Turbomachinery**	Course No.	**ME322**
Focus Group	Mechanical Engineering	L-T-P [C]	3-1-0 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To teach about different types of turbomachines used in energy transformations
2. To introduce basic principles and equation governing the steady and unsteady fluid flow associated with turbomachinery
3. To impart knowledge of designing turbines vanes using velocity triangles

Learning Outcome

1. To analyze the flow behavior which depends on the geometric configuration of various turbomachines
2. Identify and analyze the thermal cycles related to turbomachines
3. Turbo-machine stage characterization using various design parameters

Contents

Overview of power prime movers (turbomachines) used for energy conversion

1. Classification of Turbomachines, Eulers equation of Turbomachines, Concept of velocity triangles for a general case, Expression of Eulers equation showing the components of energy transfer, Dimensional analysis of incompressible Turbomachines, concept of specific speed and specific diameter, similarity laws and model testing.
2. Introduction to pumping systems, Centrifugal pumps working principle and constructional details of volute and vortex casing, Efficiencies, losses, operating characteristics, multistage pumps, NPSH, priming and cavitation
3. Potential of hydropower and Layout of hydropower plant, Hydraulic turbines, efficiencies, impulse and reaction machines, Analysis of Francis Turbine, Analysis of Kaplan Turbine, Analysis of Pelton-Turbine, performance characteristics of hydraulic turbines
4. Compressible flow Turbomachines, concept of static and stagnation states, General idea of losses, efficiencies, review of T-S and H-S diagrams of turbines and compressors, total total, total-static efficiencies, effect of reheat and preheat. Dimensional analysis of compressible flow machines. Lift and drag, nomenclature of aerofoil, blade cascading concept, turbine cascade, compressor cascade
5. Layout of gas turbine power plant, Axial flow compressors, construction details, stage velocity triangles, degree of reaction, work done factors, stalling and surging. Centrifugal compressors, construction, flow analysis, stage pressure rise, stage pressure coefficient, stage efficiency, Gas turbines
6. Steam turbine overview, impulse turbine, speed ratio, idea of velocity and pressure compounding. Reaction stages-50% and 100% reaction
7. Introduction to ventilation systems, fans and blowers, Turbomachines used in power transmission, Fluid coupling, Torque converter

Reference Books

1. Dixon, S. L., (2005), *Fluid Mechanics & Thermodynamics of Turbomachinery,* 5th Edition, Elsevier Science
2. Sheperd, D. G., *Principles of Turbomachinery,* Mac Millan
3. Kearton, W. J., *Steam Turbine Theory and Practice*, CBS Publishers & Distributors
4. Cohen, H., Rogers, G. F. C., and Saravanamuttoo, H. I. H., *Gas Turbine Theory,* Longman Publishing Group

Course Title	**Design of Machine Elements**	Course No.	**ME323**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for		Type	Compulsory for ME
Pre-requisite		To take effect from	July 2014

Objectives

1. The design and creation of devices that consist of interrelated components used to modify force and/or motion.
2. To inculcate the modes of stress concentration, failure and fatigue in components at work.

Learning Outcomes

1. Understanding for the different types of failure modes
2. To know the different types of elements used in the machine design process and to graphically represent them.

Contents

1. *Introduction to Engineering Design: Design, Mechanical Engineering/Machine Design, Design Considerations, Design Methods, Engineering Materials and their Mechanical properties Use, types of codes & standards in Design, Selection of preferred sizes, Behaviour of Ductile & Brittle material, Stress-Strain Diagram for various materials. Factor of safety.*
2. *Design for strength: Failure Criterion & problems - Maximum Normal and Shear Stress theory, Distortion energy theory, Stress Concentration, Stress concentration factor, Stresses in members subjected to axial, shear, Bending, Torsional & Eccentric loading, Fatigue Failure, Endurance Limit & Strength, Size effect, surface effect, Reliability, stress concentration effects etc. Problems on design of members for finite & infinite life in members subjected to individual & combined loading. Cumulative damage in fatigue*
3. *Design of shaft and couplings: Types, Design of solid & hollow shaft on strength and rigidity basis with steady loading subjected to pure torsion. Design of shafts carrying pulleys & gears (Combined loading). ASME Code for shaft design. Cotter & Knuckle Joints: Design procedure, Design of Flange, Bush & Pin type flexible coupling.*
4. *Design of Riveted, Bolted and Welded joints: Rivets, Types and uses, Riveted joints, Types and efficiency, design procedures, Types of weldments and symbols, Strength of welded joints, design of bolted, Eccentric loading of riveted, welded and bolted joints*
5. *Design of Mechanical springs and Levers: Helical springs, Stresses and Deflection, Design principles, Leaf springs, Stresses, Design principles, Levers, types and design procedures General design principle*
6. *Mechanical Drives: Classification and selection steps for main components of belt, rope and chain drives.*
7. *Design of Clutches and Brakes: Classification, application and design consideration of clutches and brakes*
8. *++Machine Drawing Aspects:*
9. *General principles of presentation: BIS Code of practice for Engineering Drawing, conventional representation of dimensioning and sectioning, threaded parts, gears, springs and common features. Abbreviations and symbols used in technical drawings. Symbols and method of indication on the drawing for surface finish, welding and riveted*

joints.

10. *Tolerance types and representation on the drawing: Fits types and selection for different applications Basic hole systems - Basic shaft systems Allowances. Geometric tolerances Form and positional. Datum and datum features symbols used to represent geometric tolerances.*
11. *Assembly drawing of joints, coupling and bearings: Preparation of drawing for keys and keyways, cotter joints, knuckle joints and threaded fasteners. Preparation of drawing for Couplings - Flange coupling and universal coupling, Bearings, Plummer block - Representation of tolerances in drawing.*
12. *Assembly drawing of machine elements: Preparation of assembled views using parts details - Lathe tail stock Lathe chuck - Connecting rod Screw jack - Machine vice - Tool head of shaper.*
13. *Jigs and fixtures: Jigs types-plate, latch, channel, box, post, pot jigs, automatic drill jigs - lathe, milling and broaching fixtures- Grinding, planning, shaping fixtures, and welding fixtures. Preparation of Jigs/ Fixtures for basic components.*

Reference Books

1. Shigley, J. E., Mischke, C., Nisbett, K., and Richard, B., (2008), *Mechanical Engineering Design,* McGraw Hill Education
2. Spotts, M. F. & Shamp, T. E., (2003), *Design of Machine Elements,* Prentice Hall
3. Sidheswar, K. N, & Sastry, P. V. V. V., (1997), *Machine Drawing,* Tata McGraw Hill

Course Title	**Industrial Engineering**	Course No.	**ME324**
Focus Group	Mechanical Engineering	L-T-P [C]	3-0-3 [4]
Offered for	B.Tech.	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

To impart knowledge and train students in area of industrial engineering by making them familiar with the basic concepts involved in productivity management , production planning, materials management, work study and ergonomics and their application

Learning Outcomes

1. Understanding of basics of production planning, facility location and layout and ability to carry out forecasting analysis, layout study.
2. Understanding of basics of work study, and ability to carry out time study.
3. Understanding of Materials Management and maintenance concepts ability to carry out inventory costing
4. Understanding of Ergonomics and ability to carry out posture analysis.

Contents

1. *Introduction to Industrial Engineering:* Relevance of industrial engineering for achieving performance excellence in industry. Productivity Management: Productivity measurement and improvement, Resource waste minimization, Lean manufacturing. Forecasting Analysis: Need and benefits, various qualitative and quantitative models, error analysis in quantitative forecasting. Production Planning: Aggregate production planning, pure and mixed aggregate planning strategies; Master production scheduling; material requirements planning and manufacturing resource planning (MRP I and MRP II); Plant Location & Layout: Factors effecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts.
2. *Materials Management:* Objectives and functions, Procurement, Types of inventories, Inventory costs, Inventory control models, Determination of EOQ (under deterministic conditions), Bill of materials. Product Engineering: Product design considerations, Product development, Detailing, Value Engineering and its role in product design and cost rationalization, IPR, Patents, Copyright. Maintenance Management: Objectives, Nature of maintenance problems, Maintenance strategies, Organization, Maintenance Information Systems, Spare Parts Management, Maintenance Cost Control, Introduction to Total Productive Maintenance.
3. *Work Science:* Purpose and scope, Productivity and work-study, Method Study and Work Measurement, Principles of Motion Economy, Elements of Work Sampling, Predetermined Motion Time Systems, Principles of Work Design. Ergonomics: Role of Ergonomics in industry, Introduction to anthropometry, Task analysis to reduce Musclo-Skeletal disorders, Posture analysis, Introduction to bio-mechanics, Effect of physical environment on performance

Laboratory

Lab exercises related to work study, Ergonomics, Plant layout, Exercises on Facilities Planning, forecasting, production planning, materials management.

Reference Books

1. ILO, (1992), *Work Study,* Geneva: ILO
2. Curie, R., (1992), *Introduction to Work Study,* McGraw Hill
3. Sanders, M. & McCormic, E., (1993), *Human factors in Engineering,* McGraw Hill
4. Monks, J. G., (2004), *Production/Operations Management,* McGraw Hill

Course Title	**B. Tech. Project**	Course No.	**ME399**
Focus Group	Mechanical Engineering	L-T-P [C]	0-0-9 [3]
Offered for	5th to 8th Semester	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To gain hands on experience on innovative technology project
2. To prepare the students to solve/work on the real world/practical/theoretical problems involving issues in computer science and engineering

Learning Outcomes

1. Ability to design and model a system
2. Ability to plan and execute well defined objective
3. Ability to work in team at component level and system level
4. Ability to troubleshoot
5. Ability to reuse- or integrate with- existing components
6. Ability to derive performance metrics and assess quantitatively the performance of system
7. Ability to report and present the findings in standard formats

VII Semester

Course Title	**B. Tech. Project**	Course No.	**ME498**
Focus Group	Mechanical Engineering	L-T-P [C]	0-0-18 [6]
Offered for	5th to 8th Semester	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To gain hands on experience on innovative technology project
2. To prepare the students to solve/work on the real world/practical/theoretical problems involving issues in computer science and engineering

Learning Outcomes

1. Ability to design and model a system
2. Ability to plan and execute well defined objective
3. Ability to work in team at component level and system level
4. Ability to troubleshoot
5. Ability to reuse- or integrate with- existing components
6. Ability to derive performance metrics and assess quantitatively the performance of system
7. Ability to report and present the findings in standard formats

VIII Semester

Course Title	**B. Tech. Project**	Course No.	**ME499**
Focus Group	Electrical Engineering	L-T-P[C]	0-0-18[6]
Offered for	5^{th} to 8^{th} Semester	Type	Compulsory
Pre-requisite		To take effect from	July 2014

Objectives

1. To gain hands on experience on innovative technology project
2. To prepare the students to solve/work on the real world/practical/theoretical problems involving issues in computer science and engineering

Learning Outcomes

1. Ability to design and model a system
2. Ability to plan and execute well defined objective
3. Ability to work in team at component level and system level
4. Ability to troubleshoot
5. Ability to reuse- or integrate with- existing components
6. Ability to derive performance metrics and assess quantitatively the performance of system
7. Ability to report and present the findings in standard formats

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Course Booklet for B.Tech.

(Mechanical Engineering)

2015