College of Engineering, Pune
(An Autonomous Institute of Govt. of Maharashtra,
Permanently Affiliated to S.P. Pune University)

Department of Production Engineering and Industrial Management

Curriculum Structure & Detailed Syllabus (UG Program)

Second Year B.Tech.
(Revision: A.Y. 2019-22, Effective from: A.Y. 2020-21)

UG Program Structure of B. Tech. Production Engineering (Sandwich)

w.e.f AY 2019-20 and Applicable for batches admitted from AY 2019-20 to 2022-23

[M- Group: Mechanical, Civil, Metallurgy & Material Science, Production S/W]

List of Abbreviations:

Percentage of Credits

Abbreviation	Title	No of courses	Credits	% of Credits
BSC	Basic Science Course	9	27	16.27
ESC	Engineering Science Course	5	18	10.84
MLC	Mandatory Learning Course	3	0	0.00
SLC	Self Learning Course	2	4	2.41
HSMC	Humanities/Social Sciences/Management Course	6	7	4.22
LLC	Liberal Learning Course	1	1	0.60
SBC	Skill Based Course	7	26	15.66
IFC	Interdisciplinary Foundation Course	2	4	2.41
IOC	Interdisciplinary Open Course	2	4	2.41
DEC	Department Elective Course	2	6	3.61
PCC	Program Core Course	17	49	29.52
LC	Laboratory Course	19	20	12.05
		75	166	

Semester III [Odd Term]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Ordinary Differential Equations and Multivariate Calculus	2	1	0	3
2	BSC		Biology for Engineers	3	0	0	3
3	IFC		Strength of Material	2	0	0	2
4	SBC		Product and System Graphics	0	0	2	1
5	PCC		Theory of Machines	2	1	0	3
6	PCC		Production Processes	3	0	0	3
7	PCC		Fundamentals of Metallurgy	3	0	0	3
8	LC		Production Processes Lab	0	0	2	1
9	LC		Fundamentals of Metallurgy Lab	0	0	2	1
10	LC		Theory of Machines Lab	0	0	2	1
				15	**02**	**08**	**21**
			Total Academic Engagement and Credits				

Available Credits for the Program Core: 14

For other department

			Interdisciplinary Foundation Course-I				
1	IFC		Basics of Manufacturing Engineering	2	0	0	2

Semester III [For Direct Second Year Admitted Diploma Students]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Linear Algebra and Univariate Calculus	4	1	0	5
2	BSC		Foundation of Physics	3	0	0	3
3	BSC		Biology for Engineers	3	0	0	3
4	IFC		Strength of Material	2	0	0	2
5	SBC		Product and System Graphics	0	0	2	1
6	PCC		Theory of Machines	2	1	0	3
7	PCC		Production Processes	3	0	0	3
8	PCC		Fundamentals of Metallurgy	3	0	0	3
9	LC		Production Processes Lab	0	0	2	1
10	LC		Fundamentals of Metallurgy Lab	0	0	2	1
11	LC		Theory of Machines Lab	0	0	2	1
				20	**02**	**08**	**26**
			Total Academic Engagement and Credits				

Semester IV [Even Term]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Vector Calculus and Partial Differential Equations	2	1	0	3
2	MLC		Professional Laws, Ethics, Values and Harmony	1	0	0	0
3	HSMC		Innovation and Creativity	1	0	0	1
4	IFC		Industrial Electronics and Electrical Drives	1	0	2	2
5	SBC		Rapid Prototyping Practice	0	0	2	1
6	PCC		Engineering Thermodynamics and Heat Transfer	3	0	0	3
7	PCC		Fluid Power	3	0	0	3
8	PCC		Design of Machine Elements	3	0	0	3
9	PCC		Machining Science and Technology	3	0	0	3
10	PCC		Metrology and Quality Control	2	1	0	3
11	LC		Engineering Thermodynamics and Heat Transfer Lab	0	0	2	1
12	LC		Fluid Power Lab	0	0	2	1
13	LC		Metrology and Quality Control Lab	0	0	2	1
				19	**2**	**10**	**25**
			Total Academic Engagement and Credits				

Available Credits for the Program Core: 14

Yellow Highlighted Text: AICTE recommended titles/Changed Title; Blue Highlighted Text: New Course

Interdisciplinary Foundation Course (IFC): Every department shall offer one IFC course each in semester III and IV. A department from M-Group can opt for an IFC course offered by E-Group and vice versa.

For other department

			Interdisciplinary Foundation Course-II	L	T	P	Credits
1	IFC		Industrial Engineering	2	0	0	2

Semester IV [For Direct Second Year Admitted Diploma Students]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Multi Variate Calculus and Differential Equations	4	1	0	5
2	MLC		Professional Laws, Ethics, Values and Harmony	1	0	0	0
3	HSMC		Innovation and Creativity	1	0	2	1
4	IFC		Industrial Electronics and Electrical Drives	1	0	2	2
5	SBC		Rapid Prototyping Practice	0	0	2	1
6	PCC		Engineering Thermodynamics and Heat Transfer	3	0	0	3
7	PCC		Fluid Power	3	0	0	3
8	PCC		Design of Machine Elements	3	0	0	3
9	PCC		Machining Science and Technology	3	0	0	3
10	PCC		Metrology and Quality Control	2	1	0	3
11	LC		Engineering Thermodynamics and Heat Transfer Lab	0	0	2	1
12	LC		Fluid Power Lab	0	0	2	1
13	LC		Metrology and Quality Control Lab	0	0	2	1
				21	**2**	**12**	**27**
			Total Academic Engagement and Credits				

Semester-III

(MA) Ordinary Differential Equations and Multivariate Calculus

Teaching Scheme:	Examination Scheme:
Lectures : 2 Hrs/week	T1 and T2: 20 Marks each
Tutorial: 1Hr/week	End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to:

1. Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2. Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3. Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
4. Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
5. Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)
6. Organize and present thoughts. (To measure this outcome, questions may asked to write summaries and short notes on a given topic.)

Unit 1 : . **[11 Hrs]**

Review of first order differential equations, Reduction of order, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients and reducible to differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters), systems of differential equations, applications to orthogonal trajectories, mass spring systems and electrical circuits

Unit 2 : **[07 Hrs]**

Laplace Transforms, its properties , Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform.

Unit 3 : **[08 Hrs]**

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points, constrained optimization.

Text Books:

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books:

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer Science and Business Media.
- Differential Equations with Applications and Historical notes by George Simmons, Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

Note : All the Course outcomes 1 to 3 will be judged by 75% of the questions and outcomes 4 and 5 will be judged by 25 % of questions.

( ) Biology For Engineers

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Test 1: 20 marks
Test 2: 20 marks
ESE: 60 marks

Course Outcomes:

Students will be able to:

1. Understand basic biological principles and organizational structure of living systems at molecular level
2. Comprehend basic biological principles and organizational structure of living systems at cellular level
3. Know Energy transformations and information processing in biological systems
4. Appreciate biological process with engineering perspective
5. Impart knowledge about the common corridors of biology and engineering and biologically inspired technologies

Unit 1: **(06Hrs)**

Biomolecules and biopolymers: Structure and Function Organic and inorganic molecules; Unique Properties of water, Vitamins and Minerals, Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA)

Unit 2 : **(06Hrs)**

Levels of organization of life: Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane

Levels of organization: cells, tissues, organs, systems & organism

Unit 3: **(06Hrs)**

Energy transformations in Chloroplast: Photosynthesis (photochemical & biochemical phase) and ATP generation, Aerobic and anaerobic systems

Energy transformations in Mitochondria: Cellular respiration (glycolysis and Kreb cycle) and ATP generation

Bioenergetics: Thermodynamic principles applied to biology, negative entropy changes in biological systems, Free Energy, Chemical Equilibrium

Unit 4: **(06Hrs)**

Expression and Transmission of Genetic Information: DNA replication, Enzyme driven process of DNA cloning, Protein synthesis- Transcription & translation

Techniques for optimization:

a. At molecular level: Recombinant DNA Technology, DNA hybridization, PCR, DNA microarray

Unit 5: **(06Hrs)**

Transport Phenomena in Biological Systems: Membrane channels and ion channels; Fluid flow and mass transfer (nutrients & ions); In plants: Xylem and Phloem; In animals: Blood and Lymph Transport of gases: Oxygen and Carbon dioxide
Heat Transport - Body temperature regulation.

Communication: Cell junctions, Cell-cell communications – cell signaling, Hormones, Pheromones and cell behavior

Defense mechanisms:

In plants: Herbivory, secondary metabolites, In animals: Innate and Adaptive immune systems

Unit 6: **(06Hrs)**

Engineering perspectives of biological sciences:

Biology and engineering crosstalk – At cell level: Hybridoma technology
At tissue level: Plant Tissue Culture, Animal Tissue Culture; Tissue Engineering: Principles, methods and applications Introduction to Biomimetics and Biomimicry, nanobiotechnology

References:

- Lodish H, Berk A, Zipursky SL, et al. (2000) Molecular Cell Biology. W. H. Freeman.
- Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). Lehninger principles of biochemistry. New York: Worth Publishers.
- Rao CNR, et.al. Chemistry of Nanomaterials: Synthesis, Properties and Applications.
- Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
- Palsson B.O. and Bhatia S.N. (2009) Tissue Engineering. Pearson.
- Yoseph Bar-Cohen (2005). Biomimetics- Biologically Inspired Technologies
- Joseph D. Bronzino, John Enderle, Susan M. Blanchard (1999) Introduction to Biomedical Engineering.
- Routledge Taylor and Francis group (2012). Introduction to Bio-medical Engineeering technologies

(IFC I) Strength of Materials

Teaching Scheme:
Lectures : 2 Hrs/week
Tutorial: 0 Hr/week

Examination Scheme:
100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course outcomes:
At the end of this course the student will be able to:
1. Describe properties of engineering material, their behavior and applications.
2. Explain the types of stresses and the effects of stresses in engineering applications due to different actions.
3. Analyze simple problems in engineering applications.
4. Differentiate the failure of long and short columns

Unit I **[5Hrs]**

Simple stresses and strains:
a) Concept of stress and strain (linear, lateral, shear and volumetric) Hooks law. Elastic constants and their relationship. Generalized Hook's law. b) Axial force diagram, stresses, strains and deformation in determinate and indeterminate homogeneous and composite bars under concentrated loads, self-weight and temperature changes.

Unit II **[5Hrs]**

Shear force & bending moment diagrams and Stresses due to bending
a) Shear force and bending moment diagrams Concept and definition of shear force and Bending Moment in beams due to concentrated load, UDL, uniformly varying loads and couples in determinate beams. Relation between SF, BM and intensity of loading, SF, and BM diagrams for cantilevers, simple compound beams and bend. b) Stresses due to bending Theory of simple bending, concept and assumptions, Derivation of Flexure formula. Bending stress distribution diagram. Moment of resistance and section modules calculations.

Unit III **[5Hrs]**

a) Shear stress distribution in beams Shear stresses concept, derivation of shear stress distribution formulae, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress. b) Torsion of circular shaft Theory of torsion of shafts of circular, cross section. Assumptions, Derivation of torsion formulae, stresses strains and deformation in determinate and indeterminate shafts of hollow, solid, homogeneous circular cross section subjected to twisting moments, stresses due to combine torsion, bending.

Unit IV **[5Hrs]**

a) Principal stresses and principal strain Normal and shear stresses on any oblique planes and concept of principal planes and principal planes by analytical and graphical

methods (Mohr's circle of stress 2-D). b) Pressure Vessels. Stresses, strains and deformation in thin walled seamless cylindrical and spherical vessels due to internal fluid pressure. Change in volume, effects of additional fluid injected under pressure.

Unit V **[4Hrs]**

Axially loaded columns

a) Euler Formulae Concept of critical load and buckling, derivation of Euler's formulae for buckling load with hinged ends, concept of equivalent length for various end conditions. a)Rankine's Formula Rankine's formulae, safe load on column, Limitations of Euler's formulae.

Unit VI **[4Hrs]**

Slope and Deflection of Determinate Beams

a) Concept and definition, relation between B.M., slope and deflection slope and deflection by double integration method (McCauley's method). b) Slope and Deflection in determinate beams by Moment Area method

Text Books:

Text Book

1 "Strength of Materials" By S. Ramamrutham& R Narayanan, Dhanpat Rai publication, New Delhi

2 "Mechanics of Structure" By S. B. Junnarkar and Advi, (Vol. I), Charotar publication.

Reference Books

1 "Introduction to Mechanics of Solids" by J.B. Popov, Prentice – Hall publication

2 "Mechanics of Materials" by James M.Gere (5th Edition) Brooks/Cole Thomson Learning.

3 "Strength of Material" by F. L. Singer and Pytel, Harper and Row publication.

4 "Mechanics of Material" by Beer and Johnston, Mc Graw Hill publication.

(PE 293) Product and System Graphics Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term work: 50 Marks
Practical/oral: 50 Marks

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1. Do dimensioning to the engineering drawings.
2. Represent machine components conventionally
3. Select the fits and tolerances for the designed components.
4. Draw the 2D and 3D views using software packages like AutoCAD and Catia.
5. Carryout part drawing and assembly of systems along with preparation of Bill of Material.

List of Experiments/Assignments:

1. Four A4 size sheets (using drafting package) containing different I.S. conventional representation for machine elements. Welded joints, screwed fasteners, tapers, piping layouts, method of dimensioning. I.S. conventions for method of tolerancing, fits, geometric tolerances, surface finish.
2. One imperial size sheet of drawing consisting of assembly & detail part drawings of mechanical assemblies like valves, boiler mountings, couplings, vices, pumps, engine sub-assemblies, jigs & fixtures, lathe tailstock, tool posts, gear boxes, pulley blocks, revolving center etc.
3. A sketchbook containing the sketches of above parts.
4. Computer Aided Drafting exercises: Using any Solid Modelling package.
5. Working drawing, details & assembly of any one machine component such as cotter joint, knuckle joint, flange joint, rigid & flexible coupling etc. with geometric & dimensional tolerances, surface finish etc.

() Theory of Machines

Course Outcomes:

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Students will be able to:

1. Draw velocity and acceleration diagrams for simple and complex mechanisms.
2. Use graphical and analytical methods for solving problems in static and dynamic force analysis.
3. Apply basic concepts and theory regarding friction, lubrication, belt, rope and chain drives.

Unit I **[7Hrs]**

Fundamentals of Kinematics and mechanisms: Kinematic Link, Kinematic Pair, Kinematic chain, Structure, mechanism, machine, Types of Constrained Motions, Degrees of Freedom, Grubler's Criterion for Plane Mechanisms, Equivalent linkage Mechanism, Inversions of Four Bar Chain, Single Slider Crank Chain, Double Slider Crank Chain Difference between Spatial and Planner Mechanism. Pantograph, Straight Line Motion mechanisms.Hooke's Joint / Universal Joint.

Unit II **[7Hrs]**

Velocity and Acceleration Analysis in Mechanisms: Relative Velocity (Velocity polygon) for Kinematic link. Acceleration Diagram for a Link.Corioli's component of Acceleration.Velocity and acceleration in a Slider Crank Mechanism by Klein's construction.Instantaneous Centre of Rotation (ICR).Angular Velocity Ratio Theorem, Methods of Locating ICR in a Mechanism.Velocity analysis of a Kinematic Link by ICR Method, Body and Space Centrode.

Unit III **[7Hrs]**

Static and Dynamic Force Analysis: Introduction, Static Equilibrium, Equilibrium of Two Force and Three-Force Members, Resultant effect forces acting on a rigid body, D'Alembert's Principle, Equivalent Dynamic System, Compound Pendulum, Bifilar and Trifilar suspension methods. Static and Dynamic Analysis of inertia forces of Slider-Crank Mechanism by analytical and graphical method.

Unit IV. **[7Hrs]**

Friction and Lubrication: Introduction, Types of Friction, Limiting Friction, Laws of Friction, Coefficient of Friction, Limiting Angle of Friction, Screw Friction, Screw Jack, Torque required to lift and lower the load by a Screw Jack, Efficiency of a Screw Jack, Over Hauling and Self Locking Screws, Efficiency of Self Locking Screws, Rolling Friction, Film Friction, Principles of Thick and Thin Film Lubrication, principles of hydrostatic and hydrodynamic lubrication

Unit V **[7Hrs]**

Belt and Chain Drives: Introduction, Selection of a Belt Drive, Flat and V Belt Drives, Open and cross Belt Drive. Materials used for Belts, Velocity Ratio of Belt Drive, Limiting tension ratio, Slip of Belt, Creep of Belt, Length of Flat Belts, Angle of Contact, Power Transmitted by a Belt, Maximum Power Transmitted by a Belt, Centrifugal Tension and its effect on power transmission. Initial Tension in the Belt, Design of Belt Dimensions, Chain Drive, Advantages and disadvantages of Chain drives, Terms used in Chain Drive, Angular Velocity of the Sprocket.

Unit VI **[7Hrs]**

Introduction to Gears and Governors: Classification, Terminology, Gear Characteristics, Gear Calculations, Gear Tooth Systems, Gear Tooth Profiles, Gear Materials, Law of Gearing, , Gear trains and its types, Calculation of velocity ratio for different gear trains, Gear Trains with bevel gears: Differential Gear Box.Governors: Introduction, Types of governors, Terms used in Governor, Sensitiveness, Stability and Hunting of Governor, Isochronous Governor, Governor effort and Governor power.

Text Books:

- R. S. Khurmi and J. K. Gupta, “A Text Book of Theory of Machines”, S. Chand, 14th Revised Edition, 2005.
- S.S. Ratan, “Theory of Machines”, Tata Mcgraw Hill Education Private Limited, 3rd Edition, 2009.

Reference Books:

- Ulicker Jr., J.J., Penock, G.R. and Shigley, J.E. “Theory of Machines and Mechanisms”, Tata Mcgraw Hill Education Private Limited.
- John Hannah and Stephens, R.C. “Mechanics of Machines: Advance Theory and Examples” Edward Arnold London.
- Ramamurthy, V. “Mechanics of Machines”, Narosa Publishing House.
- Thomas Beven, “Theory of Machines”, Person Education Ltd.

(ME 209) Production Processes

Teaching Scheme:
Lectures : 3 Hrs/week
Tutorial: 1 hr/week

Examination Scheme:
100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

1. Understand machine tools, mechanism and accessories used in various manufacturing processes.
2. Able to understand drillimg and milling processes.
3. Understand the different abrasive machining processes
4. Get awareness about various welding processes and can use them effectively.
5. Familiar with multiple forming processes and understand importance in manufacturing.
6. Get knowledge of Sand Casting and molding processes.

Unit I **[7Hrs]**

Metal Cutting Machine Tools and Processes: Fundamentals of turning and boring, lathe – construction, accessories, operations. Thread cutting – single and multistart threading, Different tools, tool materials, tool geometry. Concept of speed, feed, depth of cut.Capstan and Turret Lathe- Construction, Working and Applications.

Unit II. **[7Hrs]**

Drilling & Milling Machines, Shaper, Planer and Slotting Machines: Drilling: Fundamentals of drilling process, twist drill geometry, tool holders. Types of drilling machines, operations performed on drilling machines. Types of drills.Reaming process, reamers types, geometry.Introduction to boring machines – general arrangement and nature of work done.Milling Machines: Fundamentals of milling process, cutters - types and geometry. Operations performed on milling machines. Dividing head, methods of indexing. Shaper, Planer and Slotting Machines: Construction, working of quick return mechanism, operations performed

Unit III **[7Hrs]**

Abrasive Machining Processes and Surface Treatment Processes: Abrasive Machining Processes: Abrasive machining, abrasives - types, size and geometry. Grinding wheels, wheel marking, wheel selection, wheel mountings.Types of grinding machines. Honing, Lapping, Super Finishing, Buffing. Surface Treatment Processes: Importance of surface treatments, advantages, Honing, lapping, buffing, polishing, Honing tools, lapping materials. Abrasive, buffing, polishing wheels and burnishing

processes. Introduction to super treatment processes.Electroplating, Electroless plating, plasma coating, phosphating, galvanizing, metal spraying, anodizing, rubbling and tumbling.

Unit IV **[7Hrs]**

Casting Processes: Expendable Mould Casting Processes:Sand Casting, types of pattern materials, pattern making allowances, core prints, moulding sand-properties and testing, hand and machine moulding, core, core boxes, melting and pouring, study of furnaces – Cupola, fuel fired, electric arc, induction furnaces. Investment casting, shell moulding. Casting techniques of cast iron, steels and nonferrous metals of alloys; solidification; design of casting, gating and risering Cleaning, finishing and heat treatment of castings, casting defects and testing.Permanent Mould Casting Processes: Die casting, low-pressure permanent mould casting – hot and cold chamber processes, centrifugal casting, semi-centrifugal casting, centrifuging, continuous casting.

Unit V **[7Hrs]**

Hot and cold working of metals: Principles of rolling, forging, drop, press, upset, roll forging, extrusion, drawing, spinning, effects of hot working. Cold working processes, Cold rolling, swaging, forging, extrusion- forward, backward and impact roll forming, tube drawing, wire drawing, spinning, shot penning, High Energy Rate Forming.

Unit VI **[7Hrs]**

Joining Processes: Welding Processes: Theory, control and applications, Arc Welding – SMAW, GTAW, GMAW, FCAW, Submerged arc welding, etc.Resistance welding – theory, Spot, Seam, Projection welding processes etc., Gas welding. Thermit welding, Friction welding, Ultrasonic welding, Electron beam and Laser welding.Defects in welding, their cause and remedy, weldability, welding of dissimilar metals. NDT and other methods of testing welded joints. Soldering and Brazing applications.Use of adhesives for joining. Classification of adhesives, types of adhesives and their applications, surface preparation and various joints

Text Books:

- S.K. HajraChoudhary and S.K. Bose, “Elements of workshop Technology” Volume I, II, Asia Publishing House, 10th Edition 2000.
- P.N. Rao, “Manufacturing Technology”, Tata McGraw-Hill Publishing Limited, 2nd Edition, 2002.

Reference Books:

- Chapman W.A.J, “Workshop Technology”, Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

- Degarmo, Black and Kohser, “Materials and processes in Manufacturing”, Prentice Hall of India. 2nd Edition, 1998.
- Milton Shaw, “Metal Cutting Principles”, Oxford University Press, 4th Edition, 2001.
- O.P. Khanna and M. Lal, “Production Technology”, Vol. I,II, Dhanpatrai Publication, 5th Edition, 1999.
- B.S. Raghuwanshi, “Workshop Technology”, Dhanpatrai Publication, 9th Edition, 1999.

(MT213) Material Science and Technology

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to:

1. Demonstrate an understanding of the structure-property-processing correlation engineering materials.
2. Select appropriate mechanical testing for various metallic materials.
3. Distinguish among various types of steels and cast irons for particular application.
4. Select appropriate heat treatment for metals and alloys for particular application.

Unit I **[6Hrs]**

Classification of Engineering Materials: Structure-property-processing correlation, Amorphous and crystalline solids, Crystal systems and Bravais lattice, Imperfections in solids, mechanisms of plastic deformation, Plastic deformation of polycrystalline metals, Hot working, cold working.

Unit II **[6Hrs]**

Engineering Steels: Type of equilibrium diagrams in metals and alloys, lever rule. Iron - Carbon equilibrium diagram, critical temperatures. Allotropy, cooling curve and volume changes of pure iron. Microstructures of slowly cooled steels, estimation of carbon from Microstructures, non-equilibrium cooling of steels, Structures -property relationship.

Unit III **[6Hrs]**

Alloy Steels: Classification and applications of steels, specifications of some commonly used steels for engineering applications (e.g. En, DIN, IS etc. with examples), Effects of alloying elements. Classification of alloying elements, Examples of alloy steels. Stainless steels. Tool steels and tool materials.

Unit IV **[11Hrs]**

Heat Treatment of Steels: Transformation products of austenite, Time temperature Transformation diagrams, Critical cooling rate, continuous cooling transformation diagrams. Heat treatment of steels, Cooling media. Annealing, normalizing, hardening.Tempering, Carburising, nitriding, carbonitriding, Flame and Induction

hardening.Commercial heat treatment practice of gears of different sizes, tools, lathe beds, springs, etc.

Unit V **[5Hrs]**

Cast Irons: Classification of Cast irons Gray cast irons, nodular cast irons, white cast irons, malleable cast irons, chilled. Effect of various parameters on structure and properties of cast irons, Applications of cast irons for different components of machine tools, automobiles, pumps, etc.

Unit VI **[8Hrs]**

Mechanical Testing: Tension test - Engineering and true stress strain curves, Compression test, Hardness Tests: Brinell, Rockwell, Vickers, Hardness conversions, Impact test, Non Destructive Testing: Magnetic Particle test, Dye penetrant, ultrasonic tests, radiography and eddy current testing.

Text Books:

- D. R. Askland& P. P. Phule, “Material Science & Engineering of Materials”, Cengage Learning Center India Pvt Ltd. , Sixth Indian Edition, 2011.
- R. A. Higgins, Engineering Metallurgy Part-I, Applied Physical Metallurgy, ELBS with Edward Arnold, Sixth Edition 1993.

Reference Books:

- V. Raghvan, “Materials Science & Engineering”, PHI 5th Edition, Prentice-Hall of India (P) Ltd.
- W. Callister, “Materials Science & Engineering”, John Wiley & sons
- Clark D. S. and Varney W. R., “Physical Metallurgy for Engineers”, Affiliated East-West Press, New Delhi.
- R. Balasubramaniam,Callister's Materials Science and Engineering, Wiley India Pvt Ltd., 2008.
- A. K. Bhargava, Mechanical Behaviour and Testing of Materials by and C. P. Sharma, Publication PHI, 2011.

() Production Processes Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term work: 50 Marks
Practical/oral: 50 Marks

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1. Understand machine tools, mechanism and accessories used in various production processes.
2. Make the job of turning & tapper turning operation using lathe.
3. Perform Forging and grinding of lathe tool with one knife and other end vee.
4. Prepare simple solid pattern involving wood turning.
5. Perform Welding using gas/arc welding process.
6. Understand Sand Casting process

List of Experiments/Assignments:

Each candidate shall be required to complete and submit the following term work:
Jobs:

1. Plain and Taper turning – one job
2. Forging and grinding of lathe tool with one knife and other end vee – one job
3. Making a simple solid pattern involving wood turning – one job
4. Welding (gas or arc) – one job

Journal & Demonstration: Assignments on machine tools will be in the form of a journal based on demonstrations on machine tools. This should include sketches and relevant descriptions as given below:

1. Block Diagrams (Any Two).
   a) Lathe
   b) Universal milling machine
   c) Radial drilling machine
   d) Cylindrical grinder
2. Mechanisms (Any Two).
   a) All geared headstock of a center lathe.
   b) Spindle arbor (assembly) drive of milling machine
   c) Crank and slotted lever quick return drive of shaping machine.
   d) Spindle assembly in a drilling machine
3. Accessories (Any Two).
   a) Taper turning attachment for a center lathe.
   b) Universal dividing head.
   c) Milling cutters.

() Material Science and Technology Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term work: 50 Marks
Practical/oral: 50 Marks

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1. Carrying out Tensile test to evaluate characteristics of mild Steel and Aluminium.
2. Carrying out hardness test by Brinell and Rockwell methods for samples of ferrous & nonferrous materials.
3. Carrying out Impact tests on various materials.
4. Non-Destructive tests like Magnaflux testing, Dye penetrant testing and Ultrasonic testing.
5. Microstructure interpretation of different ferrous and non ferrous materials which is important for engineers to establish correlation between properties and applications.

List of Experiments/Assignments:

1. Tensile test on mild steel and aluminium test specimens.
2. Hardness test on samples of steel, cast iron, brass, aluminum, etc. by Brinell and Rockwell methods.
3. Impact tests.
4. Non-Destructive tests: Magnaflux testing, Dye penetrant testing and Ultrasonic testing.
5. Study and drawing of microstructures of mild steel, medium carbon steel, eutectoid steel and hypereutectoid steel.
6. Study and drawing of microstructures of brass. Tin bronze, Al-bronze, Babbit metal.
7. Study and drawing of microstructures of white malleable, gray and nodular cast irons.
8. Study and drawing of microstructures of hardened steel, tempered steel.

(ME 213) Theory of Machines Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term work: 50 Marks
Practical/oral: 50 Marks

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1. Determine Moment of Inertia of rigid bodies by bifilar or trifilar suspension method.
2. Verify displacement relation for different shaft angles for single Hook's Joint.
3. Develop a computer program for velocity and acceleration of slider crank mechanism Non-destructive tests like Magnaflux testing, Dye penetrant test and Ultrasonic test.
4. Graphical solution to problems on velocity & acceleration in mechanisms by Relative velocity & relative acceleration method including problem with Corioli's component of acceleration.
5. Analyzing Inertia force with graphical methods.

List of Experiments/Assignments:

List of Experiments (Any 3 experiments from the given list):

1. Determination of Moment of Inertia of rigid bodies by bifilar or trifilar suspension method.
2. Compound Pendulum.
3. Experimental Verification of displacement relation for different shaft angles for single Hook's Joint.
4. Developing a computer program for velocity and acceleration of slider crank mechanism.

List of drawing Sheets:

1. Graphical solution of problems on velocity & acceleration in mechanisms by Relative velocity & relative acceleration method including problem with Corioli's component of acceleration.
2. Graphical solution of problems on velocity in mechanisms by ICR method.
3. Klein's constructions for slider crank mechanism.
4. Inertia force analysis with graphical methods.
5. Straight line motion mechanisms.

(for Students Directly admitted to S.Y. after their Diploma)

(MA) Linear Algebra and Univariate Calculus

Teaching Scheme:	**Examination Scheme:**
Lectures : 4Hrs/week	T1 and T2: 20 Marks each
Tutorial: 1Hr/week	End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to:

1. Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2. Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3. Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
4. Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
5. Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

Unit I : [15 Hrs]

Matrices and linear equations: basic properties of matrices, row operations and Gauss elimination, Determinants and their basic properties. Basic concepts in linear algebra: vector spaces,subspaces, linear independence and dependence of vectors, bases, dimensions. Rank of a matrix . Applications to systems of linear equations.

Unit II : [12 Hrs]

Rank-nullity theorem, Eigen values, Eigen vectors and their basic properties, diagonalization.

Unit III : [12 Hrs]

Review of limits, continuity and differentiability, Mean value theorems, Taylor's theorem, local extrema, increasing and decreasing functions, concavity, points of inflection.

Unit IV : [13 Hrs]

Surface area, integrals by special techniques: reduction formulae, arc length, solids of revolution, improper integrals, tests for convergence, Gamma and Beta functions.

Text Books:

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10thedition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books:

- Introduction to Linear Algebra (2nd edition) by Serge Lang, Springer.
- Elementary Linear Algebra (10th edition) by Howard Anton and Chris Rorres, John Wiley and sons.
- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Calculus and Real Analysis (1st edition) by Sudhir Ghorpade and Balmohan Limaye, Springer-Verlag, New York.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Differential Calculus by Shanti Narayan, S. Chand and company, New Delhi.
- Applied Mathematics Vol. I (Reprint July 2014) by P.N. Wartikar and J.N. Wartikar, Pune Vidyarthi GrihaPrakashan Pune.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

( ) Foundation of Physics

Teaching Scheme:
Lectures : 2 Hrs/week
Tutorial: 1Hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to:

1. Develop the understanding of laws of thermodynamics and their application in various processes, Understanding optics and their applications.
2. Solve the problems in Classical Mechanics looking at the limitations of Classical Mechanics.
3. Derive the Wave Mechanics of microscopic bodies
4. Formulate and solve the engineering problems on Electromagnetism.

Unit I Thermodynamics: [4Hrs]

Heat as a form of energy , mechanical equivalent of heat, thermodynamic systems, Zeroth law and concept of temperature, first law & its mathematical statement, Second law and concept of entropy, third law of thermodynamics, Concept of free energy; Gibbs and Helmoltz free energy.

Unit II **[6Hrs]**

Waves motion and Optics: Longitudinal and transverse waves, Light as an EM wave and it's graphical representation,General equation of travelling wave,Superposition principle, formation of stationary waves (with derivation),Huygen's Principle, Young's double slit experiment, Interference of light due to thin film of uniform thickness and conditions for darkness and brightness, Diffraction due to a single slit; conditions of maxima and minima.

Unit III **[5Hrs]**

General Mechanics: Kinetic energy and potential energy,Work done (single particle system only); work energy theorem, Conservative and nonconservative forces, Concept of central force, properties of central force, Laws of planetary motion (with mathematical statement).

Unit IV **[5Hrs]**

Introduction to Quantum Mechanics: Drawbacks of classical mechanics, Plank's quantum hypothesis, Dual nature of matter, De Broglie's hypothesis, de Broglie's wavelength,Photoelectric effect, Davisson-Germer's experiment, Heisenberg's

uncertainty principle, Illustrations of Heisenberg's uncertainty principle; electron diffraction at a single slit

Unit V **[6Hrs]**

Electrostatics: Coulomb's law in integral form, the electric field intensity,Continuous charge distribution (Line, Surface & Volume), Introduction to Gauss's law, integral form of Gauss's law, Applications of Gauss's Law to simple 2D-3D problems, Line integral of electric field, concept of electric potential, Potential due to continuous charge distribution.

Unit VI **[4Hrs]**

Magnetostatics: Steady currents (line current ,surface current,volume current) & current densities, Magnetic field due to steady currents (Biot-Savert's law) and it's applications, Line integral of B over a closed loop, Ampere's Law and its applications to simple problems, Closed surface integral of B (Non-existence of magnetic monopole).

Reference Books:

- H. C. Verma&Halliday-Resnick (Sixth edition), B. B. Laud.
- Halliday-Resnick (Sixth edition) Optics by BrijLal (S. Chand Publication).
- by P. V. Panat, H. C. Verma, Halliday –Resnick, "Classical Mechanics",6th Edition.
- David Griffith, "Classical Electrodynamics",Pearson India limited.

FOR OTHER DEPARTMENTS

(IFC I) Basics of Manufacturing Engineering

Lectures : 2 Hrs/week

100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

1. Understand machine tools, mechanism and accessories used in various manufacturing processes.
2. Able to understand drillimg and milling processes.
3. Understand the different abrasive machining processes
4. Get awareness about various welding processes and can use them effectively.
5. Familiar with multiple forming processes and understand importance in manufacturing.
6. Get knowledge of Sand Casting and molding processes.

Unit I **[5Hrs]**

Metal Cutting Machine Tools and Processes: Fundamentals of turning and boring, lathe – construction, accessories, operations. Thread cutting – single and multistart threading, Different tools, tool materials, tool geometry. Concept of speed, feed, depth of cut

Unit II **[5Hrs]**

Drilling & Milling Machines, Shaper, Planer and Slotting Machines: Drilling: Fundamentals of drilling process, twist drill geometry, tool holders. Types of drilling machines, operations performed on drilling machines. Types of drills .Milling Machines: Fundamentals of milling process, cutters - types and geometry. Operations performed on milling machines

Unit III **[5Hrs]**

Abrasive Machining Processes and Surface Treatment Processes: Abrasive Machining Processes: Abrasive machining, abrasives - types, size and geometry. Grinding wheels, wheel marking, wheel selection, wheel mountings.Types of grinding machines. Honing, Lapping, Super Finishing, Buffing. Surface Treatment Processes: Importance of surface treatments, advantages, Honing, lapping, buffing, polishing, Honing tools, lapping materials. Abrasive, buffing, polishing wheels and burnishing processes. Introduction to super treatment processes

Unit IV **[5Hrs]**

Casting Processes: Expendable Mould Casting Processes:Sand Casting, types of pattern materials, pattern making allowances, core prints, moulding sand-properties and testing, hand and machine moulding, core, core boxes.

Unit V **[5Hrs]**

Hot and cold working of metals: Principles of rolling, forging, drop, press, upset, roll forging, extrusion, drawing, spinning, effects of hot working. Cold working processes, Cold rolling, swaging, forging, extrusion- forward, backward and impact roll forming, tube drawing, wire drawing, spinning, shot penning, High Energy Rate Forming.

Unit VI **[5Hrs]**

Joining Processes: Welding Processes: Theory, control and applications, Arc Welding – SMAW, GTAW, GMAW, FCAW, Submerged arc welding, etc. Resistance welding – theory, Spot, Seam, Projection welding processes etc., Gas welding.

Text Books:

- S.K. HajraChoudhary and S.K. Bose, “Elements of workshop Technology” Volume I, II, Asia Publishing House, 10th Edition 2000.
- P.N. Rao, “Manufacturing Technology”, Tata McGraw-Hill Publishing Limited, 2nd Edition, 2002.

Reference Books:

- Chapman W.A.J, “Workshop Technology”, Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.
- Degarmo, Black and Kohser, “Materials and processes in Manufacturing”, Prentice Hall of India. 2nd Edition, 1998.
- Milton Shaw, “Metal Cutting Principles”, Oxford University Press, 4th Edition, 2001.
- O.P. Khanna and M. Lal, “Production Technology”, Vol. I,II, Dhanpatrai Publication, 5th Edition, 1999.
- B.S. Raghuwanshi, “Workshop Technology”, Dhanpatrai Publication, 9th Edition, 1999.

Semester-IV

(MA) Vector Calculus and Partial Differential Equations

Teaching Scheme:	Examination Scheme:
Lectures : 2 Hrs/week	T1 and T2: 20 Marks each
Tutorial: 1Hr/week	End-Sem Exam: 60 Marks

Course Outcomes :

Students will be able to:

1. Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2. Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3. Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
4. Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
5. Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

Unit I : [10 Hrs]

Double integrals in Cartesian and polar co-ordinates,iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates, substitutions in multiple integrals, Applications to Area, Volume, Moments and Center of Mass.

Unit II : [07 Hrs]

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss, arc length parameterization, applications.

Unit III: [09Hrs]

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes.

Text Books:

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books:

- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Functions of several variables by Wendell Fleming, Springer-Verlag, New York.
- Partial Differential Equations (4th edition) by Fritz John, Springer.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

Professional Laws, Ethics, Values and Harmony

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

1. Students will be able to:
2. Aware about Professional Ethics and Human Values.
3. Contribute to societal and human well-being.
4. Aware about social responsibility at the personal, professional and corporate levels.
5. Understand and appreciate concept of gender diversity and related issues from an ethical viewpoint.
6. Appreciate and deal with ethical dilemmas while discharging duties in professional life.

Unit I **[4 Hrs]**

Human Values: Morals, Values and Ethics, Integrity, Work Ethic, Honesty, Commitment , Courage, Empathy, Self-Confidence, Character, Caring and Sharing, Empathy and Leadership.

Unit II **[5Hrs]**

Professional Ethics: Introduction to and history of Ethics, Profession and professionalism, Professional roles played by an engineer, Engineering ethics (supported by case studies), Moral / ethical dilemma, moral autonomy, consensus and controversy, etc., Codes of conduct and codes of ethics, Gender diversity at the workplace, women's empowerment, sexual harassment at work, etc.

Unit III **[6Hrs]**

Global Issues: Types of technology and their ethical application., Transfer of technology, its benefits and drawbacks, Role of multinational corporations in technology transfer, Environmental ethics and need for sustainable development, Environmental hazards due to irresponsible technological development, Computer ethics and IPR, and computer crime, Social problems resulting from computerization, Ethical social networking

Unit IV **[5 Hrs]**

Engineering as Social Experimentation: Meaning of experimentation in engineering, Engineers' role as responsible social, experimenters to benefit society, R&D efforts

towards ethically and environmentally sustainable design of products and systems, A balanced view towards legal, ethical and business aspects of technology use.

Unit V **[5Hrs]**

Safety, Responsibilities and Rights: Knowledge of safety and risk and the ethical need to reduce it, Uncertainty of design,Need for testing product and system designs for safety, Concept of risk benefit analysis, Ethical issues in cost-benefit analysis, Protecting employee rights, human rights and human responsibilities, Case studies involving natural and manmade disasters, (e.g. Chernobyl, Bhopal Gas Tragedy, floods in Uttarakhand, Kashmir, etc.

Unit VI **[3Hrs]**

Whistle Blowing: Meaning and brief history of whistle blowing, Internal and external whistle blowing, Ethical and legal issues involved in whistle blowing, Managing whistle blowing, Case studies involving whistle blowers like Manjunath, SatyendraDubey, etc.

Reference Books:

- H. C. Verma&Halliday-Resnick (Sixth edition), B. B. Laud.
- Halliday-Resnick (Sixth edition) Optics by BrijLal (S. Chand Publication).
- by P. V. Panat, H. C. Verma, Halliday –Resnick, “Classical Mechanics”,6th Edition.
- David Griffith, “Classical Electrodynamics”, Pearson India limited.

( ) Innovation and Creativity

Teaching Scheme:	**Examination Scheme:**
Lectures : 1 Hrs/week	"To be declared by the Instructor"

Course Outcomes:

At the end of the Course, Student will be able to:

1. Discover the creative / innovative side within herself/himself.
2. Hone entrepreneurial and leadership skills within his/her personality.
3. Develop new ways of thinking and Learn the entire innovation cycle from Ideation to Go-To-Market.
4. Study frameworks, strategies, techniques and business models for conceived ideas.
5. Develop skills for evaluating, articulating, refining, and pitching a new product or service.

Syllabus

Introduction to Innovation, Personal thinking preferences, 'Innovation' mind set, Everyday creativity and eliminating mental blocks, Introduction to Innovation, Creative thinking techniques, Innovation types, Idea management and approaches, Teaming techniques for creativity, Idea Conception, Idea Scoping, SelfEvaluation, Idea Brainstorming sessions, Idea Verification, Market Evaluation, Concept Evaluation, Idea Verification, Prototype Evaluation, Protection/Patent review, Innovation Case Study, Idea Presentations, Idea Incubation, Product and Market Plan, Product and Market Development, Innovation Case Studies, Idea Incubation and Product Launch, Marketing and selling, Post Launch Review

Reference Books:

- Jeff Dyer, Hal Gregersen, Clayton M. Christensen, " The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators, Harvard Business Review Press, 2011.
- Paddy Miller, Thomas Wedell-Wedellsborg, "Innovation as Usual: How to Help Your People Bring Great Ideas to Life , Harvard Business Review Press, Kindle Edition.

(IFC) INDUSTRIAL ELECTRONICS AND ELECTRICAL DRIVE SYSTEMS

Teaching Scheme: **Examination Scheme:**

Lecture: 1 hr/week T1 and T2: 20 marks each

Practical: 2 hrs/week End-Sem Exam: 60 marks

Course Outcomes:

At the end of this course, the students should be able to,

1. Select a suitable power electronics converter for various industrial applications.
2. Choose the electrical motors and drive for various industrial application.
3. Understand and analyze various industrial electronics systems.
4. Use a appropriate sensor for various industrial applications.

Unit 1: Power Electronics Converters [03 Hrs]

SCR, MOSFET, IGBT: characteristics, triggering, ratings and applications.

Basics of controlled rectifiers with RL and RLE loads, DC to DC converters (buck, boost and buck-boost), inverters (bridge, stepped wave, SPWM), four quadrant operation, UPS, THD and filtering requirements.

Unit 2: Electrical Motors [03Hrs]

Operation, types, characteristics, control and applications of: DC, induction and synchronous motors.

Construction, working, characteristics, control and applications of:- stepper motors, servomotors, reluctance motors, AC series motors, BLDC motor and PMSM motor.

Unit 3: Electrical Drives [04 Hrs]

Basics of electric drives, AC motors drive and DC motor drives, four quadrant operation, choice of electrical drives, load speed-torque characteristics.

Electrical drives for various applications like rolling mills, cranes, winches, traction, shear press, mechanical press, power mills, textile industry, coal and mining industry.

Unit 4: Industrial Applications and Instrumentation [04 Hrs]

Principle of electric welding and heating, ultrasonic testing, LASER applications, electronic ignition systems.

Smoke, temperature, pressure, vibrations, displacement, flow, level detectors, basics of actuators and sensors, Introduction to PLC, concept of computerized controllers.

References :

- Industrial Electronics: Chute & Chute: Electronics in Industry, Tata McGraw Hill.
- M.H. Rashid, Power Electronics –Devices Circuits and Applications. 4th edition.
- Harish C. Rai: Industrial and Power Electronics (Umesh Publication, Delhi).
- C. S. Rangan, Sharma, Mahi: Instrumentation, devices and system (WIE).
- Curtis Johnson: Process Instrumentation, Prentice Hall of India. Electrical Drive Systems:
- Pillai S. K.: First course in Electrical Drives – Wiley Eastern.

List of Experiments: Minimum 8 experiments are to be performed from following list:

1. To obtain the characteristics of SCR, MOSFET and IGBT
2. To perform triggering of SCR, MOSFET and IGBT
3. Controlled rectifiers with RL and RLE loads
4. Perform buck, boost and buck-boost converter operation
5. Study of inverters (bridge, stepped wave, SPWM)
6. To perform four quadrant operation
7. Study of UPS system.
8. Perform load test on three phase squirrel cage induction motor.
9. Perform no load and blocked rotor test on three phase squirrel cage induction motor to estimate the equivalent circuit parameters, losses and efficiency.
10. Speed control of three phase squirrel cage and slip ring induction motor
11. Perform the load test on the synchronous motor
12. Plot the characteristics of servomotors.
13. Perform the load test on the permanent magnet synchronous motor.
14. Speed control of permanent magnet brushless dc motor.
15. Demonstration of electric welding, heating and electronic ignition systems.
16. Study of smoke, temperature, pressure, vibrations, flow, level detectors.
17. Study of PLC.

Rapid Prototyping Practice

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term work: 50 Marks
Practical/oral: 50 Marks

Laboratory Outcomes:
Students will be able to

1. Understand how CAD technology can be leveraged in the additive manufacturing process
2. Compare and distinguish the difference between Solid model syntax with .STL file.
3. Understand the concept like process chain of Rapid Prototyping and its necessity in manufacturing of real life components
4. Learn the use of 3D printing software and effect of various process parameters
5. Learn the printing process on 3D printers by varying the process parameters and evaluate the quality of 3d printed components

List of Experiments/Assignments:

1. **Introduction to CAD:** This experiment will focus on the development of 3D Part with the help of CAD Modelling software
2. **Introduction to .STL File:** This experiment will cover conversion of solid model into .stl file, syntax of .stl file, errors in .stl file etc.
3. **Introduction to Additive Manufacturing Technology and AM Process Flow:** This experiment will cover the major concepts like Introduction to AM, History of AM, its various types and Process flow of AM based FDM Technology
4. **Study of 3D Printing Software:** This experiment will focus on learning of 3D Printing software and various process parameters and its effect on printing quality
5. **Printing of 3D components on FDM printer:** This experiment will give hands-on experience of using 3D printer to build the components
6. **Introduction to Post Processing techniques:** This experiment will cover the concept of Post processing, its need and actual demonstration on Post Processing machines
7. **Demonstration of various technologies under Additive Manufacturing:** This experiment will cover the learning of basic Additive Manufacturing techniques and its different industrial applications

Text Books

1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, World scientific, 2003.
2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010

3. Ali K. Kamrani, Emand Abouel Nasr, “Rapid Prototyping: Theory and Practice”, Springer, 2006.

Reference Books

- Paul C. Bave: CAD Principles and Applications
- Understanding of Additive Manufacturing, Andreas Gebhardt, Hnaser Publishers, 2011.
- D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 200

(ME 208) Engineering Thermodynamics and Heat Transfer

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

1. Use the laws of Thermodynamics to various power producing and power absorbing Devices.
2. Apply steam tables to calculate power and energy requirements of a system.
3. Understand use of steam for power generation and process heating.
4. Analyze I.C. engines and their Performance evaluation.
5. Calculate and analyze the percentage components in Fuel and Flue gas.
6. Calculate Heat transfer & evaluate performance of heat exchangers.

Unit I **[7Hrs]**

Elementary Thermodynamics: Basics of Thermodynamics, Ideal gas Laws, First Law of Thermodynamics, Steady Flow Energy Equation, Carnot Cycle, reverse Carnot Cycle, Second Law of Thermodynamics, Concept of refrigeration, Heat Pump and Heat Engine

Unit II **[7Hrs]**

Vapour power cycles Steam Generation and its properties, Measurement of dryness fraction, Carnot Cycle, Application of Gas laws to vapour processes. Ideal Rankine Cycle, Calculation of Thermal Efficiency, Specific Steam Consumption, Work ratio.
Steam Turbines: Types, construction, working, compounding, velocity diagram, & diagram efficiency (No numerical).

Unit III **[7Hrs]**

Fuels and Fundamentals of combustion: Solid, Liquid and gaseous fuels, Combustion equations, analysis of product of combustion, gravimetric and volumetric analysis, theoretical air, excess air and exhaust gas produced.

Unit IV **[7Hrs]**

I C. Engines: Air standard Otto, Diesel cycles(Elementary Numerical treatment), classifications of ICE and systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine –

Indicated power, Brake power, Thermal efficiency, Specific fuel consumption(Elementary Numerical)**.**

Unit V **[7 Hrs]**

Heat Transfer:

Introduction and Basic Concepts of Conduction: Application areas of heat transfer in manufacturing and machine tools, Modes and Laws of heat transfer, thermal conductivity, thermal diffusivity, Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance, overall heat transfer coefficient, conduction, critical radius of insulation for cylinders and spheres, economic thickness of insulation. (elementary numerical)

Fundamentals of convection: Concept Laminar and turbulent flow, Reynold Number, Prandlt number, Grashoff number, Nusselt Number. Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers.

•Fundamentals of Radiation: Fundamental concepts of radiation, different laws of radiation, Concept of: shape factor, radiation between two black and diffuse gray surfaces and radiation shields. (no numerical)

Unit VI **[7 Hrs]**

•**Heat Exchangers:**Introduction to heat exchangers, classification and applications; Heat exchanger analysis – LMTD for parallel and counter flow heat exchanger, concept of effectiveness, NTU method for parallel and counter flow heat exchanger (elementary level/ introduction, no numerical)**.**

Text Books:

- R.K. Rajput,“Thermal Engineering”, Laxmi Publications.
- R. S. Khurmi and Gupta,“Thermal Engineering”, S. Chand Publication.

Reference Books:

- S.P. Sukhatme,“Heat Transfer”, Orient Longman.
- Y.A. Cengel,“Thermodynamics – an Engineering approach”, Tata McGraw Hill.
- Eastop, A. Mc’conkey,“Applied Thermodynamics”, Pearson Publishers.
- Holman J.P.,“Heat Transfer”, Tata McGraw Hill.

() Fluid Power

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

1. Draw and read different ISO/JIC symbols used in hydraulic and pneumatic circuits.
2. Design and demonstrate hydraulic and pneumatic system components.
3. Interpret the hydraulic and pneumatic circuits with their application.
4. Troubleshoot the fault in hydraulic and pneumatic system.
5. Design and select appropriate components required for hydraulic and pneumatic systems.
6. Explain safety requirements in hydraulic and pneumatic system.

Unit I **[6Hrs]**

Fundamental concepts of fluid & Introduction to fluid power: Classification of fluids, Properties of fluids, Pascal's law, continuity equation and Bernoulli's equation, Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations, Fluids for hydraulic systems, Distribution of fluid power, ISO symbols, conditioning of fluids, study of reservoirs, strainers, filters, heat exchangers.

Unit II **[5Hrs]**

Hydraulic System elements: Pumps: Classification, principle of working and constructional details of vane pumps, gear pumps, radial and piston pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic Power transmission.Accumulators and Intensifiers: Types, working and Industrial applications.

Unit III **[12Hrs]**

Hydraulic Control Elements: Pressure control valves: construction and working of directly operated and pilot operated pressure relief valve, pressure reducing valve, sequence valve, counter balance valve.
Direction control valves: Principle and types of direction control valves, types of center positions. Flow control valves: Principles of flow control valves, construction and working of compensated and non-compensated types flow control valve.

Unit IV **[4Hrs]**

Hydraulic Actuator: Types of Linear actuator and mountings, Cushioning of cylinders, Calculation of piston velocity, thrust under static and dynamic applications, Design

considerations for cylinders, Hydraulic motors - Types- Vane, Gear, Piston types, radial piston. (Numerical treatment).

Unit V **[4Hrs]**

Hydraulic Circuits : Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed circuit, circuit for riveting machine, counter balance circuit, circuit for hydraulic press, unloading circuit, Design of hydraulic circuit for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Students are advised to refer manufacturers catalogues) (Numerical treatment).

Unit VI **[10Hrs]**

Principle of Pneumatics: Laws of compression, types of compressors, selection of compressors, comparison of Pneumatics with Hydraulic power transmissions, FRL unit, Pneumatic system control elements: Direction control valves- types and working, flow control valves, quick exhaust valve, time delay valve and shuttle valve, basic pneumatic circuit, selection of components, Application of pneumatics in low cost automation and in industrial automation.

Text Books:

- H. L. Stewart, “Hydraulic and Pneumatic Power for Production”, Industrial Publishing Corporation, 1963.
- S. R.Majumdar, “Pneumatic Systems-Principles and Maintenance”, Tata McGraw-Hill Education, 1996.

Reference Books:

- A. Esposito,“Fluid Power with Applications”, Pearson.
- R.K.Bansal,“Fluid mechanics”, Laxmi publications, New Delhi.
- S. R. Majumdar,“Oil Hydraulic Systems”,TMH.
- Vickers Sperry,“Industrial Hydraulics Manual”.
- “Hydraulic Text Book Basic Level”, Festo Controls Pvt. Ltd. Bangalore.
- “Pneumatic Text Book Basic Level”, Festo Controls Pvt. Ltd. Bangalore.
- H. L. Stewart,“Pneumatics and Hydraulics”, Taraporwala.
- Andrew Parr, “Hydraulics and Pneumatics”, A Technician’s and Engineer’s Guide, JAICO Publications.

() Design of Machine Elements

Teaching Scheme:
Lectures : 3Hrs/week

Examination Scheme:
100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

1. Well conversant with the importance of design of machine elements in their carrier.
2. Able to apply the basic knowledge of machine design to tackle the practical design problems.
3. Competent enough to design simple machine elements like shaft, keys, springs, etc.
4. Capable enough to understand and tackle the design related problems of power screws, bolted and welded joints.

Unit I **[6Hrs]**

Fundamentals and Design concepts: Design concept, Phases of design, types of design, factor of safety and its selection, Standardization and use of standards in design, preferred series, materials selection factors and process, creativity in design.

Unit II **[8Hrs]**

Design against Static Loading: Types of loads, types of stresses; tensile, compressive, direct and torsional shear, bending stresses, Design of cotter joint, knuckle joint, theories of failure.

Unit III **[6Hrs]**

Shafts, Keys and Couplings: Types of shafts, materials, standard sizes of transmission shaft, Design of shafts subjected to bending, twisting moment, Design based on rigidity basis, Design of keys and splines, Design of couplings.

Unit IV **[6Hrs]**

Threaded Joints and Power Screws: Standard threads, stresses in screw fastenings, Design of bolted joints, Design of power screws, stresses in power screws, Design of turn buckle.

Unit V **[6Hrs]**

Welded Joints: Strength of transverse fillet and parallel fillet welded joints, strength of

butt joints, stresses in welded joints, axially loaded unsymmetrical welded sections, welds subjected to bending and torsional moment

Unit VI **[5 Hrs]**

Design of springs: Spring configurations, materials, design of helical compression, Extension and Torsion springs. Design of leaf springs.Nipping of spring.

Text Books:

- V. B. Bhandari,“Design of Machine Elements”, Tata McGraw Hill Publication.
- R. S. Khurmi, J.K. Gupta, “A text book of Machine Design”, S. Chand publication.

Reference Books:

- J.E. Shigley and CR. Mischke, “Mechanical Engineering Design”, 5th Edition, McGraw Hill Publication.
- Hall and Helowenko, “Machine Design”, Schaum Series.
- M.F. Spotts,“Design of Machine Elements”, Prentice Hall Publication.
- Phela,“Fundamentals of Machine Design”, McGraw Hill Publication.
- “Design data” compiled by Faculty of Mech. Engg., PSG College of Tech.,Coimbatore.

() Machining Science and Technology

Teaching Scheme:	Examination Scheme:
Lectures : 3 Hrs/week	100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

1. Demonstrate understanding of metal cutting principles and mechanism to solve the problems based on cutting force analysis and tool life.
2. Understand the design procedure of various tools and solve the problems based on tool design.
3. Understandbroachingmachines, toolsusedinthe process and design methodology to solve the problems based on broach tool design
4. Understand the various methods of gear manufacturing and thread manufacturing.
5. Classify the various non-conventional machining processes and learn its industrial applications.

Unit I **[8Hrs]**

Theory of Metal Cutting : Cutting tools, tool geometry,Conceptofspeed,feed,depth of cut and cutting action and effect of these on cutting forces.Types of Chips. Merchant's circle of forces. Shear angle, Shear Strain, Mechanics of metal cutting,Theories of shear angle. Velocity vector diagram, estimation of cutting forces. Empirical Relations,Tool Force dynamometers, Measurement of cutting forces and power required. Heat Generation in Metal Cutting, Cutting Fluids.

Unit II **[6Hrs]**

Cutting Tool Materials.HeatTreatmen tof Tool s and alloys. Machinability Tool Life and Tool Wear, New technology in metal cutting for higher productivity. Compliance test**.**

Unit III **[6Hrs]**

Design of CuttingTools: Design Principles of cutting tools andtool holders.Single point tools,Tip tools, Drills, Reamers, Broaches, Milling cutters, Threadcutting tools, Gear cutting tools, Grinding Wheels,Form Tools.

Unit IV [**6Hrs]**

Gear Manufacturing: Gear cutting process forming and generation. Gear cutting on milling. Gear hobbing. Gear shaping. Gear shaving, Lapping and Grinding.Various machinesused for gear manufacturing.

Unit V **[6Hrs]**

Thread Manufacturing: Thread cutting internal and external, chasers, dies, thread milling, rolling, lapping and grinding.

Unit VI **[10Hrs]**

Non-conventional Machining Processes: Introduction, principle, setup, operation and applications- Chemical machining, Electrochemical machining, Electric discharge machining, Electron Beam machining, Ion Beam machining, Plasma Arc machining, Laser Beam Machining, Abrasive Jet machining,Ultrasonic Machining.

Text Books:

- P. N. Rao, “Manufacturing Technology”, Tata McGraw-Hill Publishing Limited, IIE dition, 2002.
- P. K. Mishra, “Non Conventional Machining”, Narosa Publishing House (January 15, 2001), ISBN: 978-81-7319-138-1, Reprint 2008.

Reference Books:

- Donaldson, Lecain and Goold,“Tool Design”,Tata McGraw Hill, Edition:III.
- “Advanced Machining Processes”,Vijay K. Jain Allied Publishers Pvt. Ltd.,Edition I 2007.
- Prakash Joshi,“Cutting Tools”,Wheeler Publishing, ISBN 81-85814-53-8, Edition I 1996.
- David A Stephenson, John S Agapiou ,“Metal Cutting Theory and Practice”, CRC Press Edition II.

(PCC) Metrology and Quality Control

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2 - 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

1. Able to understand different linear and angular measuring instruments and measurement system analysis.
2. Design limit gauges as per the manufacturing requirements.
3. Select appropriate measurement techniques for geometric features.
4. Understand screw thread and gear metrology and automated inspection systems.
5. Develop an ability of problem solving and decision making. Suggest measures to improve the quality of product and reduce cost.
6. Carryout data collection and use statistical tools for analysis.

Unit I **[8 hrs]**

Introduction: Meaning of Metrology, Precision, Accuracy, Methods and Errors in Measurement, Calibration.

Limits, Fits and Tolerances: Meaning of Limit, Fits and Tolerance, Cost – Tolerance relationship, concept of Interchangeability, Indian Standard System.

Linear Measurement: Standards, Line Standards, End Standard, Wavelength Standard, Classification of Standards, Precision and Non Precision Measuring instruments and their characteristics, Slip Gauges.

Measurement System Analysis:-Introduction, Influence of temperature, operator skills and the instrument errors etc. on the MSA, Gauge R and R study.

Unit II **[8 hrs]**

Design of limits Gauges: Types, Uses, Taylor's Principle, Design of Limit Gauges, Three surface Generation.

Interferometry: Introduction, Flatness testing by interferometry, NPL Flatness Interferometer.

Study of Measuring Machines, Recent Trends in Engineering Metrology, use of interferometery for length angle and surface roughness measurement

Angle Measurement: Sine bars, Sine Centers, Uses of sine bars, angle gauges, Auto Collimator Angle Dekkor, Constant deviation prism.

Unit III **[6hrs]**

Inspection of Geometric parameters: Straightness, Flatness, Parallelism, Concentricity, Squareness, and Circularity.

Comparators: Uses, Types, Advantages and Disadvantages of various types of Comparators.

Surface Finish Measurement: Surface Texture, Meaning of RMS and CLA values, Roughness Measuring Instruments, Tactile and Non-tactile measuring instruments, difference between waviness and roughness, Grades of Roughness, Specifications, Assessment of surface roughness as per IS, Relationship between surface roughness and Manufacturing Processes.

Unit IV **[8hrs]**

Screw Thread Metrology: External Screw Thread terminology, Floating Carriage Instruments, Pitch and flank Measurement of External Screw Thread, Application of Tool Maker's Microscope, Use of Profile Projector.

Gear Metrology: Spur Gear Parameters, Gear tooth thickness measurement: Gear tooth Vernier calliper, Constant chord method, Span Micrometer.

Measuring Machines:-Theory of Co-ordinate Metrology, Universal Measuring Machines, Co-ordinate Measuring Machines (CMM), different configurations of CMM, Principle, Error involved, calibration, Probing system**,** automated inspection system**.**

Unit V **[5hrs]**

Introduction: Meaning of Quality, Approaches- Deming's Approach, Juran's Approach, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, and Difference between Inspection, Quality Control and Quality Assurance, Role of Quality in Present day environment.

Introduction to Quality Control: 1) Meaning of quality Control 2) 100% Inspection and Selective Inspection 3) Statistics in Selective inspection.

Total quality management (T.Q.M):-7 tools of Problem Solving, Like Cause and Effect Diagram, Pareto Analysis etc., Q.F.D., Quality Circles, Kaizen, six sigma, 5S System, ISO standards.

Unit VI **[5hrs]**

Introduction to Statistical Quality Control: Interpretation of SPC Charts, benefits for use on shop floor, Control charts- Attribute (P, nP, C, U) and Variable (X bar, R chart and X&R chart), Sampling inspection, OC Curves and Sampling Plan, Process Capability Index (Cp, Cpk), Concept, Methods of determining Cp and Cpk.

Reliability Engineering: Concept, Definitions of MTTF, MTBF, FEMA.

Text Books:

- R. K. Jain, A Text book of Engineering Metrology, Khanna Publications. Pvt. Ltd.18th Edition, 2002
- S.P.Gupta, Statistical Methods, Danpat Rai and Sons, New Delhi, 2007

Reference Books:

- John S. Oahland, Total Quality Management, Elsevier Publications, 3rd Edition 2006.
- P. N. Mukerjee,Total Quality Management, Prenice Hall of India Publications, 2nd Edition 2005.
- Amitava Mitra, Fundamental of Quality Control and improvement, Prenice Hall of India Publications, 2nd Edition 2006.

- G.M.S. De Silva, Basic Metrology for ISO 9000 Certification Elsevier Publications, 3rd Edition 2002.
- I.C.Gupta, A Text book of Engineering Metrology, Dhanpat Rai Publications Pvt. Ltd.6th Edition, 2004

(ME 212) Engineering Thermodynamics and Heat Transfer Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term Work: 50 Marks
Practical/Oral: 50 Marks

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1. Understand and study MPFI and Bish fuel injection pump
2. Analyze I.C. engines and determine thereparmeters.
3. Perform various test on parallel and counter flow heat exchanger.

List of Experiments/Assignments:

Term work consists of following experiments (Any Eight)

1. Determination of dryness fraction of steam.
2. Trial on bomb calorimeter.
3. Study of MPFI and Bosh fuel injection pump
4. Study of High Pressure Boilers.
5. Test on Diesel/Petrol engine to determine BP, bsfc, Brake thermal efficiency.
6. Trial on reciprocating air compressor.
7. Determination of thermal conductivity of insulating material.
8. Test on parallel & counter flow heat exchanger.
9. Determination of Emissivity of a Test Plate.

(ME 214)Fluid Power Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme : Term Work: 50 Marks
Practical/Oral: 50 Marks

Laboratory Outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1. Understand basics of fluid power and application to a particular requirement
2. Measure of viscosity by using Redwood viscometer and also calculate losses of flow.
3. Study and understand functioning of different types of actuators, valves and pumps, pressure regulations
4. Know speed regulations and use of hydraulic trainer kit to develop hydraulic circuit for a given operation
5. Understand basics of fluid power and application to a particular requirement
6. Study and understand functioning of various components of hydraulic and pneumatic system.

List of Experiments/Assignments:

The term work consists of the following experiments (Any 6 experiment)

1. Assignment on ISO symbols for different components of Hydraulic and Pneumatic system
2. Verification of Bernoulli's theorem
3. Following experiments to be done on hydraulic trainer:
   a. Regenerative circuit
   b. Speed control circuit
   c. Sequencing circuit
   d. Transverse and feed circuit
4. Following experiments to be done on pneumatic trainer:
   a. Automatic reciprocating circuit
   b. Speed control circuit
   c. Pneumatic circuit involving shuttle valve/ quick exhaust valve
   d. Electro pneumatic valves and circuit
5. Design of simple hydraulic systems for a given application and selection of components from Commercial catalogs.
6. At least one industrial visit to study industrial applications of hydraulics and pneumatics with Submission of the relevant report.

7. Study of pressure, direction and flow control valves in hydraulics and pneumatics using cut section models.

(LC) Metrology and Quality Control Laboratory

Teaching Scheme	Examination Scheme
Practical:2 Hrs/week	Term-work: 50 marks
	Oral: 50 Marks

Course Objectives:

1. To introduce practical aspects of metrological instruments to the students
2. To train the students in dimensional and surface metrology
3. To impart Basic knowledge of measurement system analysis
4. To impart the knowledge of control charts and quality control in manufacturing environment

Term Work / Experiments:

The term work shall consist of the record of the following experiments and assignments.

1. Determination of Linear/Angular dimensions of a part using Precision and Non Precision measuring Instruments.
2. Precision angular measurement using a) Sine Bar, b) Auto Collimator, c) Angle Dekkor.
3. Machine Tool alignment tests on any machine tool like Lathe, Drilling Machine or Milling machine (minimum three tests)
4. Measurement of screw thread parameters using Floating Carriage Micrometer.
5. Measurement of Gear parameters: a) Gear Tooth thickness and depth, b) constant Chord, c) Span Measurement, d) Pitch Circle Diameter.
6. Surface Finish measurement using suitable instrument.
7. Interferometry : Measurement of surface flatness using optical flat.
8. Study and Measurement of parameters using Profile Projector.
9. Exercise on Design of Limit Gauges using Taylor's Principles.
10. Study and Measurement of parameters using Tool Makers Microscope.

Assignments

1. Assignments on t, F and Chi Square distributions
2. Assignments on Correlation and Regression

Course Outcomes:

1. Understand principle, construction and working of various measuring instruments,
2. Selection of proper instruments for measurement.
3. Calculation of least count of instrument, take reading using the instrument
4. Interpret the observations & results.
5. Collection and recording of data and analysis of data.

For other departments

(IFC II) Industrial Engineering

Teaching Scheme:
Lectures :2 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to:

1. Ability to understand the concept of organization and types of ownership.
2. Ability to apply various methods of principles of Work study & improve the productivity.
3. Ability to apply various methods of principles of method study and time study.
4. Ability to apply various methods of principles of Work measurement techniques.
5. Ability to understand the need of personnel management and training of workers.
6. Ability to apply various techniques for ergonomic considerations in man machine system.

Unit I **[5Hrs]**

Evolution of Industrial Management: Evolution - Importance of Industrial Management – Scientific Management - Meaning definitions - principles - Importance and Criticism. Organisation : Concept of organisation, characteristics of organisation, elements of organisation, organisational structure, organisation charts, Types of organisation- formal line, military or scalar organisation, functional organization, line & staff organisation, project organisation, matrix organisation, authority and responsibility, span of control, delegation of authority. Industrial ownership: Types of ownership- single ownership, partnership, joint stock company, co- operative societies, public sector, private sector, scientific management- review of different schools of thoughts.

Unit II **[5Hrs]**

Productivity and Work Study: Definition of productivity, individual enterprises, task of management. Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programmers, wages and incentives (no numerical problem). Definition, objective and scope of work-study. Human factors in work-study. Work study and management, work-study and supervision, work-study and worker.

Unit III **[5Hrs]**

Method Study: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation - process charts, flow process charts, travel chart and multiple activity charts. Charts to record movement at work place - principles of motion. economy, classification of moments, two handed process chart,

SIMO chart, and micro motion study. Development, definition and installation of the improved method, brief concept about synthetic motion studies.

Unit IV **[5Hrs]**

Work Measurements: Definition, objectives and benefit of work measurement. Work measurement techniques.Work sampling - need, confidence levels, sample size determinations, random observation, conducting study with the simple problems.Time study - definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination.

Unit V **[5Hrs]**

Personnel Management: Concept, Importance, objectives, functions of personnel management. Recruitment and Selection: Recruitment Policy, Sources of recruitment, Selection Procedure, Steps in selection.Employee Training: Need, Aims, Importance, Steps in Training programme, methods of training, training evaluation.Performance Appraisal: Meaning, Purposes, Methods, Ethics in appraisal.Wage and Salary Administration: Nature and purpose of wage and salary administration, methods of wage payment, Time, Piece, incentive systems, Halsey, Rowan, and Taylor's differential piece rate plan.

Unit VI **[5Hrs]**

Ergonomics: Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system. Components of man- machine system and their functions - work capabilities of industrial worker, study of development of stress in human body and their consequences.

Text Books

1) Basu S.K., Sahu K.C and B. Rajiv, Industrial Organization and Management –. PHI New Delhi, 2012.
2) Edited by George Kanavaty, Introduction to Work Study-ILO, , Fourth Revised Edition, 1992

Reference Book

1) M.S. Sanders and E.J. McCormick, "Human Factors in Engineering Design", VI Edition, McGraw Hill
2) R.M. Barnes, "Motion and Time Study", Wiley International, 1980
3) S. Dalela and Sourabh, "Work Study and Ergonomics". Standard Publishers, Latest Edition

(MA) Multivariate Calculus and Differential Equations

Teaching Scheme:	**Examination Scheme:**
Lectures :4 Hrs/week	T1 and T2: 20 Marks each
Tutorials : 1hr / week	End-Sem Exam: 60 Marks

Course Outcomes: Students will be able to

1. know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2. understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3. analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
4. give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
5. apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

Unit I **[9 Hrs]**

Review of first order differential equations, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters).

Unit II **[7Hrs]**

Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform

Unit III **[7 Hrs]**

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points.

Unit IV **[12 Hrs]**

Double integrals in Cartesian and polar co-ordinates,iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates.

Unit V **[10 Hrs]**

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss.

Unit VI **[7 Hrs]**

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, one dimensional heat equation.

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Text Books:

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books:

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer Science and Business Media.
- Differential Equations with Applications and Historical notes by George Simmons, Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Functions of several variables by Wendell Fleming, Springer-Verlag, New York.
- Partial Differential Equations (4th edition) by Fritz John, Springer.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.