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

Department of Manufacturing Engineering and Industrial Management

Curriculum Structure & Detailed Syllabus (UG Program)

Second Year B. Tech. (Manufacturing Science and Engineering)
(Revision: A.Y. 2020-21, Effective from: A.Y. 2021-22)

Program Education Objectives (PEOs):

The Undergraduate students will demonstrate:

I. **PEO1**: Advance professionally as a result of his/her ability to solve complex technical problemsusing the knowledge of mathematics, science, engineering and humanities and to work in multidisciplinary areas whose solutions lead to significant societal benefits.

II. **PEO2**: Demonstrate professional engineering competence to real life problems and compete successfully using principles of manufacturing and time and quality management in the design and manufacture of products and services.

III. **PEO3**: Exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning.

Program Outcomes (POs):

The Undergraduate Students will demonstrate:

a. Graduates will apply the basic knowledge of mathematics, science, engineering and humanities to Production Engineering field

b. Graduates will have the ability to define the problems and provide solutions by designing and conducting experiments, interpreting and analyzing data for manufacturing.

c. Graduates will design manufacturing systems that would encompass machining science and technology, production processes, metal forming, tool and die design with the fully acquaintance with engineering thermodynamics and heat transfer, theory of machines, strength of material and would meet specifications and requirements as demanded by the customers.

d. Graduates will apply design and tooling for manufacturing, Kinematics of Machine Elements, Quality Control, modeling of manufacturing systems to solve production engineering problems.

e. Graduates understand manufacturing technologies like computer controlled processes and Industrial Engineering, production management, SCLM, and Total Quality Management concepts.

f. Graduates will have the confidence to apply engineering solutions in global and societal contexts.

g. Graduates will understand quantitative modeling and analysis of a broad array of systems-level decision problems concerned with economic efficiency, work design, productivity and quality with environmental focus.

h. Graduates should be capable of self-education and clearly understand the value of achieving perfection in their professional endeavors.

i. Graduates will participate as members of engineering and science laboratory teams, as well as members of multidisciplinary design teams

j. Graduates will be proficient in English language in both verbal and written forms which will enable them to compete with graduates of international engineering institutions.

k. Graduates will have the ability to choose and apply appropriate resource management technique/s so as to optimally utilize resources in manufacturing systems.

l. Graduates will be broadly educated and will have an understanding of the impact of engineering on society and demonstrate awareness of contemporary issues.

Correlation between the PEOs and PO's/PSO's

Program Objectives		Program Outcome												Program Specific Outcomes		
		a	b	c	d	e	f	g	h	i	j	k	l	PSO1	PSO2	PSO3
PEO's	I	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
	II	✓	✓	✓	✓	✓	✓					✓	✓	✓		
	III	✓	✓				✓		✓	✓	✓		✓			✓

Program Specific Outcomes:

After completion of the program, the graduates should be able to:

PSO1: Apply knowledge of manufacturing systems, Industrial Engineering and analytical techniques to solve real world problems.

PSO2: Apply knowledge of machine tool design, measurement systems, quality control and management systems to identify, formulate and solve complex engineering problems.

PSO 3: Design, develop and manufacture innovative products using emerging manufacturing and computing technologies like CAD/CAM/CIM, Rapid prototyping, machine learning, artificial intelligence etc.

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
BSC	Basic Science Course	9	27	16.3
ESC	Engineering Science Course	5	19	11.4
MLC	Mandatory Learning Course	4	0	0
SLC	Self Learning Course	2	6 (Scheme A) 4 (Scheme B)	3.6
HSMC	Humanities/Social Sciences/Management Course	6	8	4.8
LLC	Liberal Learning Course	1	1	0.6
SBC	Skill Based Course	8	15 (Scheme A) 17 (Scheme B)	9.0
IFC	Interdisciplinary Foundation Course	2	4	2.5
IOC	Interdisciplinary Open Course	3	6	3.6
DEC	Department Elective Course	2	6	3.6
PCC	Program Core Course	19	56	33.8
LC	Laboratory Course	19	18	10.8

CURRICULUM STRUCTURE OFS. Y.B.TECH (Manufacturing Science and Engineering)

Effective from A. Y. 2021-2022

III-Semester:

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-20001	Ordinary Differential Equations and Multivariate Calculus	2	1	0	3
2	BSC	AS-20001	Biology for Engineers	3	0	0	3
3	IFC	CE(IF)-20001	Strength of Material	2	0	0	2
4	SBC	PE-21001	Product and System Graphics	0	1	2	2
5	PCC	ME-20009	Theory of Machines	2	1	0	3
6	PCC	PE-21002	Manufacturing Processes	3	0	0	3
7	PCC	PE-21003	Material Science and Technology	3	0	0	3
8	LC	PE-21004	Manufacturing Processes Laboratory	0	0	2	1
9	LC	PE-21005	Material Science and Technology Laboratory	0	0	2	1
10	LC	ME-20011	Theory of Machines Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**15**	**3**	**8**	**22**

For other department

Sr. No.	Course Type	Course Code	Interdisciplinary Foundation Course-I	L	T	P	Credits
1	IFC	MFG(IF)-21001	Introduction to Manufacturing Processes	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	MA-20002	Linear Algebra and Univariate Calculus	4	1	0	5
2	BSC	PH-20001	Foundation of Physics	3	0	0	3
3	BSC	AS-20001	Biology for Engineers	3	0	0	3
4	IFC	CE(IF)-20001	Strength of Material	2	0	0	2
5	SBC	PE-21001	Product and System Graphics	0	1	2	2
6	PCC	ME-20009	Theory of Machines	2	1	0	3
7	PCC	PE-21002	Manufacturing Processes	3	0	0	3
8	PCC	PE-21003	Material Science and Technology	3	0	0	3
9	LC	PE-21004	Manufacturing Processes Laboratory	0	0	2	1
10	LC	PE-21005	Material Science and Technology Laboratory	0	0	2	1
11	LC	ME-20011	Theory of Machines Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**20**	**3**	**8**	**27**

IV-Semester:

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-20004	Vector Calculus and Partial Differential Equations	2	1	0	3
2	MLC	ML-20004	Professional Laws, Ethics, Values and Harmony	1	0	0	0
3	HSMC	HS-20004	Innovation and Creativity	1	0	0	1
4	IFC	EE(IF)-20002	Industrial Electronics and Electrical Drives	1	0	2	2
5	SBC	PE-21006	Rapid Prototyping Practice (an "I-D-P: Ideate-Develop- Prototype" team Micro-project)	0	0	2	1
6	PCC	ME-20012	Engineering Thermodynamics and Heat Transfer	3	0	0	3
7	PCC	ME-20013	Fluid Power	2	1	0	3
8	PCC	ME-20010	Design of Machine Elements	3	0	0	3
9	PCC	PE-21007	Machining Science and Technology	3	0	0	3
10	LC	ME-20014	Engineering Thermodynamics and Heat Transfer Laboratory	0	0	2	1
11	LC	ME-20015	Fluid Power Laboratory	0	0	2	1
12	LC	PE-21008	Machining Science and Technology Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**16**	**2**	**10**	**22**

For other department

Sr. No.	Course Type	Course Code	Interdisciplinary Foundation Course-II	L	T	P	Credits
1	IFC	PE(IF)-21002	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	MA-20006	Multi Variate Calculus and Differential Equations	4	1	0	5
2	MLC	ML-20004	Professional Laws, Ethics and Values	1	0	0	0
3	HSMC	HS-20004	Innovation and Creativity	1	0	0	1
4	IFC	EE(IF)-20002	Industrial Electronics and Electrical Drives	1	0	2	2
5	SBC	PE-21006	Rapid Prototyping Practice (an "I-D-P: Ideate-Develop- Prototype" team Micro-project)	0	0	2	1
6	PCC	ME-20012	Engineering Thermodynamics and Heat Transfer	3	0	0	3
7	PCC	ME-20013	Fluid Power	2	1	0	3
8	PCC	ME-20010	Design of Machine Elements	3	0	0	3
9	PCC	PE-21007	Machining Science and Technology	3	0	0	3
10	LC	ME-20014	Engineering Thermodynamics and Heat Transfer Laboratory	0	0	2	1
11	LC	ME-20015	Fluid Power Laboratory	0	0	2	1
12	LC	PE-21008	Machining Science and Technology Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**18**	**2**	**10**	**24**

III-Semester

MA 20001 Ordinary Differential Equations and Multivariate Calculus

Teaching Scheme	Examination Scheme
Lectures: 2 hrs/week	100 marks: Continuous evaluation-
Tutorial: 1 hr/week	Assignments /Quiz 40 Marks,
	End-Sem Exam – 60 Marks

Course Outcomes:

At the end of this course students will be able to:

- Identify first order ordinary differential equations, tell Laplace transform formulae and define functions of several variables.
- Understand basic concepts of higher order ordinary differential equations, level curves and level surfaces.
- Solve linear differential equations using different methods, find Laplace transforms of functions using properties and theorems, evaluate directional derivatives and extreme values.
- Prove theorems, solve ordinary differential equations using Laplace transforms, identify orthogonal trajectories and optimize functions subject to given constraints.
- Apply concepts of ordinary differential equations and multivariate calculus to various applications including real life problems.

Unit 1 **(11hrs)**

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 **(8hrs)**

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

Unit 3 **(7 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.

Textbooks:

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

Reference Book:

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by SudhirGhorpade and BalmohanLimaye, 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 (7^{th}edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2^{nd}edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

AS-20001 Biology for Engineers

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

Course Outcomes:

At the end of this course students will be able to:

- Understand basic biological principles and organizational structure of living systems at molecularlevel.
- Comprehend basic biological principles and organizational structure of living systems at cellularlevel.
- Know Energy transformations and information processing in biologicalsystems.
- Appreciate biological process with engineeringperspective.
- Impart knowledge about the common corridors of biology and engineering and biologically inspiredtechnologies.

Unit 1 **(6 hrs)**

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

Unit 2 **(6 hrs)**

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 **(6 hrs)**

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 **(6 hrs)**

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

Techniques for optimization:

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

Unit 5 **(6 hrs)**

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 **(6 hrs)**

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 Bio mimetics, Biomimicry, Nano biotechnology.

Textbooks:

- Joseph D. Bronzino, John Enderle, Susan M. Blanchard (1999) Introduction to Biomedical Engineering.
- Rao CNR, et.al. Chemistry of Nano materials: Synthesis, Properties and Applications.

Reference Book:

- 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). Lehningerprinciples of biochemistry. New York: Worth Publishers.
- 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). Bio mimetics- Biologically Inspired Technologies
- Routledge Taylor and Francis group (2012). Introduction to Bio-medical Engineering technologies

IFC/CE(IF) 20001 Strength of Material

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 students will be able to:

Course outcomes:
At the end of this course the student will be able to:

- Describe properties of engineering material, their behavior and applications.
- Explain the types of stresses and the effects of stresses in engineering applications due to different actions.
- Analyze simple problems in engineering applications.
- Differentiate the failure of long and short columns

Unit 1 **(5 hrs)**

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 2 **(5 hrs)**

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.
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Unit 3 **(6 hrs)**

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 4 **(5 hrs)**

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 5 **(4 hrs)**

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, Rankine's Formula, safe load on column, Limitations of Euler's formulae.

Unit 6 **(4 hrs)**

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.

Textbooks:

- "Strength of Materials" By S. Ramamrutham& R Narayanan, Dhanpat Rai publication, New Delhi
- "Mechanics of Structure" By S. B. Junnarkar and Advi, (Vol. I), Charotar publication.

Reference Books

- "Introduction to Mechanics of Solids" by J.B. Popov, Prentice – Hall publication
- "Mechanics of Materials" by James M. Gere (5th Edition) Brooks/Cole Thomson Learning.
- "Strength of Material" by F. L. Singer and Pytel, Harper and Row publication.
- "Mechanics of Material" by Beer and Johnston, Mc Graw Hill publication.

PE 21001 Product and System Graphics

Teaching Scheme	**Examination Scheme**
Tutorial: 1 Hr/Week	Term-work: 50 Marks
Practical: 2 hrs/week	Oral: 50 Marks

Laboratory Outcomes:

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

- Do dimensioning to the engineering drawings.
- Represent machine components conventionally
- Select the fits and tolerances for the designed components.
- Draw the 2D and 3D views using software packages like AutoCAD and Catia.

- 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.

ME 20009 Theory of Machines

Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/week	100 marks: Continuous evaluation-
Tutorial: 1 Hrs/Week	Assignments /Quiz 40 Marks,
	End - Sem Exam – 60 Marks

Course Outcomes:

At the end of this course students will be able to:

- Draw velocity and acceleration diagrams for simple and complex mechanisms.
- Use graphical and analytical methods for solving problems in static and dynamic force analysis.
- Apply basic concepts and theory regarding friction, lubrication, belt, rope and chain drives.
- Understand the terminologies, classifications and calculations related to gears.
- Understand the classification, terminologies, sensitivity, stability and hunting of governor.

Unit 1 **(7 hrs)**

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 2 **(7 hrs)**

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 Centro.

Unit 3 **(7 hrs)**

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 4 **(7 hrs)**

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 5 **(7 hrs)**

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 6 **(7 hrs)**

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.

Textbooks:

- 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.

PE-21002 Manufacturing Processes

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	100 marks: Continuous evaluation-
Tutorial: 1 Hrs/Week	Assignments /Quiz 40 Marks,
	End - Sem Exam – 60 Marks

Course Outcomes:

At the end of this course students will be able to:

- Understand machine tools, mechanism and accessories used in various manufacturing processes.
- Able to understand drilling and milling processes.
- Understand the different abrasive machining processes.
- Get awareness about various welding processes and can use them effectively.
- Familiar with multiple forming processes and understand importance in manufacturing.
- Get knowledge of Sand Casting and moulding processes.

Unit 1 **(7 hrs)**

Casting Processes.
Sand Casting, types of pattern materials, pattern making allowances, core prints, Moulding sand-
propertiesandtesting,handandmachineMoulding,core,coreboxes,Meltingandpouring,Study of furnaces – cupola, fuel fired, Electric arc, Induction furnaces, Investment casting, Shellmoulding, Casting techniques of cast iron, Steels and nonferrous metals of alloys,Solidification,Design of casting, Gating and riser Cleaning, Finishing and heat treatment of castings, defectsincasting,Permanent Mould Casting Processes, Diecasting,Low-pressurepermanentmouldcasting–hotandcoldchamberprocesses,Centrifugal casting, Semi-centrifugal casting, Centrifuging, Continuouscasting.

Unit 2 **(6hrs)**

Turning, Boring, Related Processes:
Fundamentals of turning and boring, Lathe – construction, accessories, operations, Thread cutting – single and multi-start threading, Different tools, Tool materials, Tool geometry, Concept of speed, feed, Depth of cut, Capstan and Turret Lathe- Construction, Working and Applications, Introduction to boring machines – general arrangement and nature of work done.

Unit 3 **(7 hrs)**

Drilling and Milling Machines:
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, Milling Machines, Fundamentals of milling process, Cutters - types and geometry, Operations performed on millingmachines,Dividinghead,methodsofindexing,Geartraincalculationsforhelicalandcammilling, Shaper, Planer and Slotting Machines, Construction,workingofquickreturnmechanism,operationsperformed.

Unit 4 **(7 hrs)**

Abrasive Machining Processes:

Abrasivemachining,abrasives-types,sizeandgeometry,Grindingwheels,W heelmarking,Wheel selection, Wheel mountings, Types of grinding machines, Honing, Lapping, Super Finishing, Buffing.

Surface treatment processes:

Honing, lapping, Buffing, Polishing, Honing tools, lapping materials. Abrasive, Buffing, Polishingwheelsandburnishingprocesses,Electroplating,Electrolessplating,Plasmacoating,Phosphating,Galvanizing, Metal spraying, Anodizing, Rubbling andtumbling.

Unit 5 **(7 hrs)**

Hot and cold working of metals:

Principles of rolling, Forging, Drop, Press, Upset, Roll forging, Extrusion, Drawing, Spinning, Effectsof hot working, Cold working processes, Cold rolling, Swaging, Forging, extrusion- forward,Backward and impact roll forming, Tube drawing, Wire drawing, Spinning, Shot penning, Highenergy rate forming.

Unit 6 **(7 hrs)**

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.

Textbooks:

- 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, 2 ndEdition, 2002.

Reference Books:

- Chapman W.A.J, “Workshop Technology”, Volume I, II, III, CBS Publishers and kdistributors, 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.

PE-21003 Material Science and Technology

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

Course Outcomes:
At the end of this course students will be able to:

- Demonstrate an understanding of the structure-property-processing correlation engineering materials.
- Understand the various equilibrium diagrams of metals and alloys.
- Select appropriate mechanical testing for various metallic materials.
- Understand the classification and applications of alloy steels.
- Distinguish among various types of steels and cast irons for particular application.
- Select appropriate heat treatment for metals and alloys for particular application.

Unit 1 **(6 hrs)**

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 2 **(6 hrs)**

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 3 **(6 hrs)**

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 4 **(11 hrs)**

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 5 **(5 hrs)**

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 6 **(8 hrs)**

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.

Textbooks:

- 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.

PE-21004 Manufacturing 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:

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

PE-21005 Material Science and Technology Laboratory

Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/week	Term work: 50 Marks
	Practical/oral: 50 Marks

Laboratory Outcomes:

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

- Carrying out Tensile test to evaluate characteristics of mild Steel and Aluminum.
- Carrying out hardness test by Brinell and Rockwell methods for samples of ferrous & nonferrous materials.
- Carrying out Impact tests on various materials.
- Non-Destructive tests like Magnaflux testing, Dye penetrant testing and Ultrasonic testing.
- 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:

Termwork:

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

1. Tensile test on mild steel and aluminum test specimens.
2. Hardness test on samples of steel, cast iron, brass, aluminum, etc. by Brinell

andRockwell methods.
3. Impact tests.
4. Non-Destructive tests: Magnaflux testing, Dye penetrant testing and Ultrasonictests.
5. Study and drawing of microstructures of mild steel, medium carbon steel, eutectoidsteel 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-20011 Theory of Machines Laboratory

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term-work: 50 Marks
Oral: 50 Marks

Laboratory Outcomes:

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

- Determine Moment of Inertia of rigid bodies by bifilar or trifilar suspension method.
- Verify displacement relation for different shaft angles for single Hook's Joint.
- Develop a computer program for velocity and acceleration of slider crank mechanism.
- Graphical solution to problems on velocity & acceleration in mechanisms by Relative velocity & relative acceleration method including problem with Corioli's component of acceleration.
- Analyzing Inertia force with graphical methods.

List of Experiments/Assignments:

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

Jobs:

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.

Interdisciplinary Foundation Course-I

MFG(IF) 20001 Introduction to Manufacturing Processes

Teaching Scheme
Lectures: 2 Hrs/week

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

Course Outcomes:

At the end of this course students will be able to:

- Understand various Industrial processes and its applications.
- Understand the overview of casting and forming processes.
- Understand various joining processes and their use in various applications.
- Understand various methods of conventional machining processes.
- Classify the various advanced machining processes and learn their industrial applications.
- Importance and overview of additive manufacturing processes and learn their industrial applications.
- Classify the various non-conventional machining processes and learn its industrial applications.

Unit 1 **(6 hrs)**

Casting and Forming Processes: Introduction ofcasting processes and equipment; Special Casting Processes, Introduction of forming processes; Bulk deformation processes; Sheet-metal forming processes and equipment; Plastic Processing.

Unit 2 **(6 hrs)**

Joining Processes: Introduction of joining processes; Fusion welding Processes: Gas welding, Arc Welding, Resistance Welding, High energy beam welding processes; Solid-state Welding Processes; Solid-liquid state welding: Brazing, Soldering; Adhesive bonding; Mechanical Fastening.

Unit 3 **(6 hrs)**

Conventional Machining Processes: Introduction of material removal processes; Chip removal processes: Turning, Milling, Drilling, Shaping, Broaching, Gear cutting; Abrasion Processes: Polishing, Grinding, Honing, Lapping.

Unit 4 **(6 hrs)**

Introduction to Advanced Machining Processes: Introduction, Chemical machining, Electro chemical machining, Electric discharge machining, Electron Beam machining, Laser

Beam Machining, Abrasive Jet machining, Ultrasonic Machining.

Unit 5 **(4 hrs)**

Additive Manufacturing Processes: Importance and overview of Additive Manufacturing Processes; Classification of Additive Manufacturing Processes: Vat polymerization, Powder Bed Fusion; Material Extrusion; Material Jetting; Binder Jetting; Direct energy deposition; Sheet laminations.

Textbooks:

- SeropeKalpakjian& Steven R. Schmid, "Manufacturing processes for Engineering materials", 8th Edition, Pearson Publishing.
- P. N. Rao, "Manufacturing Technology", Tata Mc Graw-Hill Publishing Limited, II Edition, 2002.

Reference Books:

- P.K. Mishra, "Non-Conventional Machining", Narosa Publishing House (January15, 2001), ISBN: 978-81-7319-138-1,Reprint 2008.
- "Advanced Machining Processes",VijayK. 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.
- D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 20

Semester III [For Direct Second Year Admitted Diploma Students]

MA-20002 Linear Algebra and Univariate Calculus

Teaching Scheme	**Examination Scheme**
Lectures: 4hrs/week	100 marks: Continuous evaluation-
Tutorial: 1Hr/week	Assignments /Quiz 40 Marks,
	End - Sem Exam – 60 Marks

Course Outcomes:

At the end of this course students will be able to:

- 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.)
- Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)

- Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
- 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.)
- 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 1 **(15hrs)**

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 2 **(12hrs)**

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

Unit 3 **(12hrs)**

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

Unit 4 **(13hrs)**

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

Textbooks:

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10^{th}edition) 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.

PH-20001 Foundation of Physics

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

Course Outcomes:

At the end of this course students will be able to:

- Understand classical and wave mechanics to implement for the problems.
- Understand of the laws of thermodynamics to implement in various thermodynamic systems and processes.
- Understandatomic Nucleus and static properties of nucleus.
- Understand the basic principles of Electromagnetism and formulate it to solve the engineering problems.
- Aware of limits of classical physics and will be able to use it in the appropriate field inorder to solve the problems.

Unit 1 **(7 hrs)**

Oscillations, Waves & Light: SHM, Characteristics of SHM, Waves, Travelling waves and its equation, Types of waves, Principle of Superposition, Stationary waves, Light as an EM Wave, graphical representation of EM wave, Interference of light due to thin film (uniform thickness), Antireflection coating, Total Internal reflection, Introduction to Optical fiber and its design.

Unit 2 **(7 hrs)**

Atomic Nucleus and Nuclear energy: Atomic Nucleus, Nuclear force, Static properties of nucleus, Mass defect and Binding energy, Law of radioactive decay, Half-life, Applications of radioactivity, Nuclear reactions, Q-value of nuclear reaction, Nuclear fission, chain reaction and Nuclear energy.

Unit 3 **(7 hrs)**

Electrostatics: Coulomb's law in vector form,the electric field, Continuous charge distribution (Line, Surface& Volume), Divergence of E, application of Gauss's law (simple 2 D problems), The curl of E (Faraday's Law), the concept of electric potential V, Potential due to continuous charge distribution.

Unit 4 **(7 hrs)**

Magneto statics: Steady state current (line current, Surface current and volume current), current densities, Magnetic field due to steady current (Biot-Savart's law), divergence and

curl of B, Statement of Ampere's Law (with simple examples).

Unit 5 **(7 hrs)**

Elements of Thermodynamics: Concept of Temperature, Terminology in Thermodynamics, Thermodynamic work, Caparison for Heat and Work, First Law and its applications, Heat engine and Thermal efficiency, Second law, Entropy, Disorder of system, Third law and Principle of Unattainability Absolute Zero (Nernst's Theorem).

Unit 6 **(7 hrs)**

Modern physics: Drawbacks of Classical Mechanics, Plank's quantum hypothesis, Dual nature of matter, DeBroglie's hypothesis, light as a particle(Compton's experiment), De-Broglie's wavelength, Heisenberg's uncertainty principle(position and momentum), Wave function, its properties, conditions and its physical significance, Free particle solution of wave function.

Textbooks:

- Engineering Physics, Avadhanulu and Kshirsagar.
- Halliday-Resnick (Sixth edition) "Optics", Brij Lal (S. Chand publication).

Reference Books:

- Classical Electrodynamics, David Griffith (Pearson India limited).
- H .C. Verma & Halliday-Resnick (Sixth edition), B. B. Laud.
- Modern Physics, S. Chand Publication.
- Concepts of Modern Physics, Arthur Beiser, Tata McGraw – Hill Edition.

IV-Semester

MA-20004 Vector Calculus and Partial Differential Equations

Teaching Scheme	Examination Scheme
Lectures: 2 Hrs/week	100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

Students will be able to:

- 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.)
- Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
- Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
- 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.)
- 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 1(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 2(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 3(09Hrs)

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

Textbooks:

- Thomas' Calculus (14^{th} edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10^{th} 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

ML 20004 Professional Laws, Ethics, Values and Harmony

Teaching Scheme	**Examination Scheme**
Lectures : 1 hrs/week	100 marks: Continuous evaluation-
Tutorial : ----	Assignments /Quiz 40 Marks,
	End - Sem Exam – 60 Marks

Course Outcomes:

At the end of this course student will be able to:

- Grasp the meaning of the concept – Law.
- Get an overview of the laws relating to Engineers.
- Apprehend the importance of being a law abiding person.
- Self-explore by using different techniques to live in harmony at various levels.
- Analyze themselves and understand their position with respect to the moral and ethical character needed for a successful and satisfactory work life.

Unit 1 **(2hrs)**
Concept of Law
Understanding Essentials of a Valid Contract and the basics of contract law protecting rights and obligations

Unit 2 **(3hrs)**
Law of Torts
Introduction to the law of torts and the basics to protect oneself and the company, Law affecting the Workplace, Employers Responsibilities / Duties, Hiring Practices, Introduction to intellectual property law.

Unit 3 **(1hrs)**
Professional Code of Conduct for Engineers
Relationship between Law and Ethics

Unit 4 **(2hrs)**
Self Awareness
Understanding oneself and others, Johari Window- Concept, explanation, Implementation.

Unit 5 **(2hrs)**

Needs & Self

Needs and its importance; Understanding harmony and its relevance in actualization at personal and professional levels

Unit 6 **(2hrs)**

Ethics and values

Professional ethics and their importance for students; Understanding the importance of values & their application in everyday life

Textbooks:

- Business Law- By Saroj Kumar
- Law of Contract- By Avtar Singh
- Business Law- By G K Kapoor

Reference Books:

- Business & Commercial Laws – By Sen &Mitra
- Business Law for Engineers- by Calvin Frank Allen
- Hilgard, E. R.; Atkinson, R. C. & Atkinson, R.L. (1975). Introduction to Psychology. 6th Edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Govindarajan, M; Natarajan, G. M. &Senthilkumar, V.S. (2013). Professional Ethics & Human Values. Prentice Hall: New Delhi
- Gogate, S. B. (2011). Human Values & Professional Ethics. Vikas Publishing: New Delhi.
- Jayshree Suresh, RaghavanB.S. (2016). Human Values & Professional Ethics: S Chand & Company.Pvt.Ltd: New Delhi.

HS 20004 Innovation and Creativity

Teaching Scheme	**Examination Scheme**
Lectures : 1 hrs/week	100 marks: Continuous evaluation-
Tutorial : ----	Assignments /Quiz 40 Marks,
	End - Sem Exam – 60 Marks

Course Outcomes:

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

- Discover the creative / innovative side within herself/himself.
- Hone entrepreneurial and leadership skills within his/her personality.
- Develop new ways of thinking and Learn the entire innovation cycle from Ideation to Go-To-Market.
- Study frameworks, strategies, techniques and business models for conceived ideas.
- 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.

Textbooks:

- Jeff Dyer, Hal Gregersen, Clayton M. Christensen, " The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators, Harvard Business Review Press, 2011.

Reference Books:

- Paddy Miller, Thomas WedellWedellsborg, "Innovation as Usual: How to Help Your People Bring Great Ideas to Life, Harvard Business Review Press, Kindle Edition

EE(IF) 20002 Industrial Electronics and Electrical Drive

Teaching Scheme	**Examination Scheme**
Lectures : 1 hrs/week	100 marks: Continuous evaluation-
Practical: 2Hr/week	Assignments /Quiz 40 Marks,
	End - Sem Exam – 60 Marks

Course Outcomes:

At the end of this course students will be able to:

- Select a suitable power electronics converter for various industrial applications.
- Choose the electrical motors and drive for various industrial application.
- Understand and analyze various industrial electronics systems.
- Use an EE (IF)-20002 appropriate sensor for various industrial applications.

Unit 1 **(3hrs)**

Power Electronics Converters

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 **(3hrs)**

Electrical Motors

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 **(4hrs)**

Electrical Drives

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 **(4hrs)**

Industrial Applications and Instrumentation

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.

Textbooks:

- Industrial Electronics: Chute & Chute: Electronics in Industry, Tata McGraw Hill.
- Curtis Johnson: Process Instrumentation, Prentice Hall of India. Electrical Drive Systems:

Reference Books:

- 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).
- Pillai S. K.: First course in Electrical Drives – Wiley Eastern.

PE 21006 Rapid Prototyping Practice

Teaching Scheme
Practical : 2Hrs/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:

- Understand how CAD technology can be leveraged in the additive manufacturing process
- Compare and distinguish the difference between Solid model syntax with .STL file.
- Understand the concept like process chain of Rapid Prototyping and its necessity in manufacturing of real life components
- Learn the use of 3D printing software and effect of various process parameters
- 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:** Thisexperiment 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:

- Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles and Applications", World scientific 2003.
- Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
- Ali K. Kamrani, EmandAbouel 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 ofRapid Prototyping and Rapid Tooling, Springer 20

ME 20012 Engineering Thermodynamics and Heat Transfer

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

Course Outcomes:

At the end of this course students will be able to:

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

Unit 1 **(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 2 **(7hrs)**

Steam Turbines: Types, construction, working, compounding, velocity diagram, & diagram efficiency (No numerical), 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.

Unit 3 **(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 4 **(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 5 **(7hrs)**

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 6 **(7hrs)**

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.

ME 20013 Fluid Power

Teaching Scheme
Lectures : 3Hrs/week

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

Course Outcomes:

At the end of this course students will be able to:

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

Unit 1 **(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 2 **(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 3 **(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 4 **(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 5 **(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 6 **(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.

ME-20010 Design of Machine Element

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

Course Outcomes:

At the end of this course students will be able to:

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

Unit 1 **(6 hrs)**

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 2 **(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 3 **(6 hrs)**

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 4 **(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 5 **(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 6 **(5hrs)**

Design of springs: Spring configurations, materials, design of helical compression,

Extension and Torsion springs, Design of leaf springs, Nipping of spring.

Textbooks:

- J.E. Shigley and CR. Mischke, “Mechanical Engineering Design”, 5th Edition, McGraw Hill Publication.
- Phela, “Fundamentals of Machine Design”, McGraw Hill Publication.

Reference Books:

- Hall and Helowenko, “Machine Design”, Schaum Series.
- M.F. Spotts,“Design of Machine Elements”, Prentice Hall Publication.
- “Design data” compiled by Faculty of Mech. Engg., PSG College of Tech.,Coimbatore.

PE-21007 MachiningScience andTechnology

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

Course Outcomes:

Studentswill be able to:

- Demonstrateunderstandingofmetalcuttingprinciplesandmechanismtosolvethe problemsbasedon cutting force analysisand toollife.
- Understandthedesignprocedureofvarioustoolsandsolvetheproblemsbasedontooldesign.
- Understand the broaching machines,tools used in theprocessanddesignmethodologyto solve theproblems basedonbroachtool design.
- Understandthevariousmethodsofgearmanufacturingandthreadmanufacturing.
- Classifythevariousnon-conventionalmachiningprocessesandlearnitsindustrialapplications.

Unit 1 (8hrs)

TheoryofMetalCutting: Cuttingtools,toolgeometry, Concept of speed, feed, depthofcutandcuttingactionand effectoftheseoncuttingforces, TypesofChips,Merchant’scircleofforces,Shear angle,Shear Strain,Mechanicsofmetal cutting, Theoriesofshear angle,Velocityvectordiagram,estimationofcuttingforces,EmpiricalRelations, ToolForcedynamometers,Measurementofcuttingforcesandpowerrequired,HeatGenerationin MetalCutting,CuttingFluids.

Unit 2 (6hrs)

CuttingToolMaterials: Heat TreatmentofToolsandalloys,Machinability,ToolLifeandTool Wear,New technologies in metal cutting for higher productivity, Compliance test.

Unit 3 (6hrs)

DesignofCutting Tools: DesignPrinciplesofcuttingtoolsand toolholders. Singlepointtools, Tiptools,Drills,Reamers,Broaches,Millingcutters,Thread cuttingtools,Gearcuttingtools,GrindingWheels, FormTools.

Unit 4(**6hrs)**

GearManufacturing: Gearcuttingprocessformingandgeneration,Gearcuttingonmilling,Gearhobbing,Gearshaping,Gearshaving,LappingandGrinding, Variousmachines usedforgear manufacturing.

Unit 5(6hrs)

ThreadManufacturing: Threadcuttinginternalandexternal,chasers,dies,threadmilling, rolling,lappingandgrinding.

Unit 6(10hrs)

Non-conventionalMachiningProcesses: Introduction,principle,setup,operationandapplications-Chemicalmachining,Electrochemicalmachining,Electricdischargemachining,ElectronBeammachining,IonBeammachining,PlasmaArcmachining,LaserBeamMachining,AbrasiveJetmachining, UltrasonicMachining.

TextBooks:

- P.N.Rao,"ManufacturingTechnology",TataMcGraw-HillPublishingLimited,IIEdition,2002.
- P.K.Mishra,"NonConventionalMachining",NarosaPublishingHouse(January15,2001), ISBN:978-81-7319-138-1,Reprint2008.

ReferenceBooks:

- Donaldson,LecainandGoold,"ToolDesign",TataMcGrawHill,Edition:III.
- "AdvancedMachiningProcesses",Vijay K.JainAlliedPublishersPvt.Ltd.,EditionI2007.
- PrakashJoshi,"CuttingTools",WheelerPublishing,ISBN81-85814-53-8,EditionI1996.
- DavidAStephenson,JohnSAgapiou,"MetalCuttingTheoryandPractice",CRCPress EditionII/

ME 20014 Engineering Thermodynamics and Heat Transfer Laboratory

Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/week	Term Work: 50 Marks
	Practical/Oral: 50 Marks

Laboratory Outcomes:

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

- Understand basics of thermodynamics and application to a particular requirement
- Understand and study MPFI and Bish fuel injection pump
- Analyze I.C. engines and determine parameters.

- Perform various tests 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-20015 Fluid Power Laboratory

Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/week	TermWork: 50 Marks
	Practical/Oral: 50 Marks

Laboratory Outcomes:

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

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

List of Experiments/Assignments:

Each student shall be required to complete and submit the following term work.

1. Verification of Bernoulli's theorem and finding coefficient of discharge for the venturimeter.
2. Measurement of viscosity by using Redwood viscometer
3. Calculation of major and minor losses for flow through pipes
4. Study of different types of actuators, valves and pumps
5. Study of pressure regulator circuits for machine tools.
6. Study of speed regulation using meter-in, meter-out and head-off
7. Study of hydraulic press circuit.
8. Use of hydraulic trainer to develop hydraulic circuit for a given operation

PE-21008 Machining Science and Technology Laboratory

Teaching Scheme	**Examination Scheme**

Practical:2 hr/week

Term work- 50 marks
Practical/Oral- 50 marks

Course Outcomes:
At the end of the course, students should be able to:

- Use different Non-Conventional processes for the given applications.
- Know about the different types of tool force dynamometers and its applications in evaluating forces acting on single point cutting tool, drilling tool and milling cutter.
- To plan and create the external threads using CNC Lathe and spur gear using vertical milling machine.
- To build the practical knowledge of Micro EDM process for precision gear cutting using Micro Wire EDM machine.

Term work:
Each student shall be required to complete and submit the following term work.

Part A

- To measure the cutting force, tool temperature and shear angle during orthogonal cutting (on Lathe).
- To measure the cutting force on drilling machine and milling machine.
- Manufacturing of external threads using CNC lathe.
- Manufacturing of spur gear using vertical milling machine.
- Study of Micro EDM process and Precision gear cutting using Hybrid Micro Wire EDM machine.

Part C
A journal consisting of:

- Tool force dynamometer, it's working principle and construction.
- Study of milling machine and CNC Lathe machine.
- Study of Hybrid Micro Wire EDM machine.

FOR OTHER DEPARTMENTS

PE(IF) 20002 Industrial Engineering

Teaching Scheme
Lectures : 2 Hrs/week

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

Course Outcomes:

At the end of this course students will be able to:

- Understand the concept of organization and types of ownership.
- Apply various methods of principles of Work study & improve the productivity.
- Apply various methods of principles of method study and time study.
- Apply various methods of principles of Work measurement techniques.
- Understand the need of personnel management and training of workers.
- Apply various techniques for ergonomic considerations in man machine system.

Unit 1 **(5 hrs)**

Evolution of Industrial Management: Evolution - Importance of Industrial Management – Scientific Management - Meaning definitions - principles - Importance and Criticism.Organization : Concept of organization, characteristics of organization, elements of organization, organizational structure, organization charts, Types of organization- formal line, military or scalar organization, functional organization, line & staff organization, project organization, matrix organization, 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 2 **(5 hrs)**

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 3 **(5 hrs)**

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 4 **(5 hrs)**

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 5 **(4hrs)**

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 differenti1al piece rate plan.

Unit 6 **(4hrs)**

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.

Textbooks

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

Reference Book

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

Semester IV [For Direct Second Year Admitted Diploma Students]

MA-20006 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

- 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.)
- Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
- Analyze the problem and apply the appropriate concept. (To measure this outcome, questions will be based on applications of core concepts)
- Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, proving implications or corollaries of theorems, etc.)
- 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 1(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 2(7Hrs)

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

Unit 3(9 Hrs)

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

Unit 4(12Hrs)

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

Unit 5(10Hrs)

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

Unit 6(7Hrs)

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

Textbooks:

- Thomas' Calculus (14^{th} edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10^{th} 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 (4^{th} edition) by Fritz John, Springer.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.

- Advanced Engineering Mathematics (7^{th} edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2^{nd} edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.