UG Program Structure
[B.Tech: Mechanical Engineering]
Structure [M] Group

w.e.f A.Y. 2019-20 &applicable for batches admitted from A.Y. 2019-20 to 2022-23

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

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

Semester III [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Ordinary Differential Equations and Multivariate Calculus And Linear Algebra and Univariate Calculus (for Students Directly admitted to S.Y. after Diploma)	2	1	0	3
2	BSC		Biology for Engineers	3	0	0	3
3	IFC		Industrial Electronics and Electrical Drive Systems (offered by Electrical Department)	2	0	0	2
4	SBC		Manufacturing Engineering - I Lab	0	0	2	1
5	PCC		Engineering Thermodynamics	3	0	0	3
6	PCC		Machine Drawing and Computer Graphics	2	0	0	2
7	PCC		Manufacturing Engineering-I	3	0	0	3
8	PCC		Strength of Materials	3	0	0	3
10	LC		Machine Drawing and Computer Graphics Lab	0	0	4	2
11	LC		Strength of Materials Lab	0	0	2	1
			Total	18	1	8	23
			Total Academic Engagement and Credits	**27**			**23**

Semester IV [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Vector Calculus and Partial Differential Equations And Multivariate Calculus and Differential Equations (for Students Directly admitted to S.Y. after Diploma)	2	1	0	3
2	MLC		Professional Laws, Ethics and Values	1	0	0	0
3	HSMC		Innovation and Creativity	1	0	0	1
4	IFC		Smart Materials (offered by Metallurgy Department)	2	0	0	2
5	PCC		Theory of Machines – I	3	0	0	3
6	PCC		Fluid Mechanics	3	0	0	3
7	PCC		Fundamentals of Metallurgy	2	0	0	2
8	PCC		Manufacturing process - II	3	0	0	3
9	LC		Rapid Prototyping Practice using Manufacturing process - II	0	0	2	1
10	LC		Fluid Mechanics Lab	0	0	2	1
11	LC		Fundamentals of Metallurgy Lab	0	0	2	1
12	LC		Theory of Machines Lab-I	0	0	2	1
			Total	17	1	10	22
			Total Academic Engagement and Credits	**28**			**22**

Semester III [M-Group]

(MA) ORDINARY DIFFERENTIAL EQUATIONS AND MULTIVARIATE CALCULUS

S.Y. B.Tech. Semester III (All Branches)

Teaching Scheme
Lectures : 2 hrs / week
Tutorials : 1 hr / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 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, 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.)

***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.

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

Unit 3: (07 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 (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 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 (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.

(MA) LINEAR ALGEBRA AND UNIVARIATE CALCULUS

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

Teaching Scheme
Lectures : 4hrs / week
Tutorials : 1 hr / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 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, 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.)

***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.

Unit 1: (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 2: (12 Hrs)
Rank-nullity theorem, Eigen values, Eigen vectors and their basic properties, diagonalization.

Unit 3: (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 4: (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 (10th 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 SudhirGhorpade and BalmohanLimaye, Springer-Verlag, New York.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7thedition) 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 VidyarthiGrihaPrakashan Pune.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

() BIOLOGYFORENGINEERS

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1 (Classroom activity): 20 marks
Internal Test 2 (Assignments): 20 marks
End Sem. Exam: 60 marks

Course Outcomes:
Students will be able to

- To understand basic biological principles and Organizational structure of Living systems at molecular level
- To understand basic biological principles and Organizational structure of Living systems at cellular and system level
- To understand Energy transformations in biological systems
- To understand Information processing in Biological systems
- To understand biological process with engineering perspective
- To 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: Evolution of multi-cellularity, 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 Cholorplast: 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 processof DNA cloning
Protein synthesis: Transcription & translation
Techniques for optimization:
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 and animals:

- 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

Reference Books:

- 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

Table 1.2: Additional topics to be discussed with students (in branch-wise manner)

Understanding various diseases/ disorders with respect to the physiology, diagnosis, therapeutics (biomaterials and instrumentation) and medical procedures e.g. Cardiovascular, Renal, Aurthopedic etc.

Disease/ Disorder	Physiology	Diagnosis	Therapeutics		Medical procedure
			Biomaterials	Instrumentation	
Cardiovascular disease	Heart – electrical stimulation and mechanical	ECG, Angiography	Stents for angioplasty	Heart lung machines	Angioplasty, By-pass surgery

	pumping				
Bone/skull injuries	Biomechanics of musculo-skeletal system	Medical imaging technologies Arthroscopy	Prosthetics	Arthroscope Biomechanics Prosthetics	Joint replacement Total hip replacementrehabilitati-on engg
Kidney disorders	Functioning of Kidney	Medical imaging technologies	Filtration membranes	Dialyser	Dialysis

(EE) INDUSTRIAL ELECTRONICS AND ELECTRICAL DRIVE SYSTEMS

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:
Student will be able to:

- Select a suitable power electronics converter for various industrial applications.
- Choose appropriate IC for various industrial applications.
- Use a right sensor for various industrial applications.
- Evaluate and analyze the parameters, operating characteristics and performance of various motors.
- Study various electrical machines and their applications in for appropriate application.

Unit 1: (5hrs)
Power Electronics Devices and Converters
Power control devices, their characteristics, protection and applications: SCR, Triac, Power MOSFET, IGBT. Triggering circuits using Diac/UJT and digital logic.Light dimmers and fan regulators, controlled rectifiers.Basics of DC to DC and DC to AC convertors, UPS.

Unit 2: (5hrs)
Integrated Circuits and Applications
Op-Amp IC 741, audio power Op-Amp, wave form generator (square and ramp), Schmidt trigger, IC 555 as mono-stable and astable multi vibrator, sequential timers, cascading of timers, adder, sub tractor, shift registers, counters, opto isolators and opto couplers. Applications in mechanical engineering such as staircase, traffic light, lift controller.

Unit 3: (5hrs)
Industrial Devices and Applications
Smoke, temperature, pressure, vibrations, displacement, flow, level detectors, proximity switches, controllers using sensors.Analog to digital and digital to analog converters, introduction to PLC, concept of distributed control systems, concept of computerized numerical controllers. Resistance welding, RF heating energy storage welding, ultrasonic method of testing of materials, principles of LASER and applications, CRO as a display device for industrial application, electronic weighing systems, electronic ignition systems.

Unit 4: (5hrs)
DC Machines and Drives
Construction of DC machines, armature and field systems, types.Generator operation: emf equation, characteristics and applications, armature reaction, commutation process, losses and efficiency.Motor operation: back emf, torque equation, characteristics, starting, speed control, braking, losses and efficiency, selection of motors for various applications.Basic DC motors drives systems: operation and applications.

Unit 5: **(5hrs)**

Induction Motor, Special Motors and Drives

Three phase induction motor construction, revolving magnetic field, motoring operation, types, circuit model, no load and on load operation, power output, torque developed, torque- speed characteristic, speed control, starting and braking, losses and efficiency, applications, induction generator principle.Basic induction motor drives systems: operation and applications.Working principle, construction, characteristics, speed control and applications (descriptive treatment only) of single phase induction motors. Working principle, construction, characteristics, speed control and applications (descriptive treatment only) of stepper motors, servomotors, hysteresis motors, and reluctance motors, AC series motors and universal motors.

Unit 6: **(5hrs)**

Synchronous Machines and Drives

Three-phase synchronous machines: construction, different types, principle of operation, emf equation, synchronous reactance, equivalent circuit, voltage regulation and efficiency, motoring and generating operation, power and torque expressions, V and inverted V characteristics of synchronous motors, starting, braking and speed control, regulation of an alternator.Basic synchronous motor drives systems: operation and applications.Selection and applications of electrical drives, selection of power rating based on thermal limits, over load and load variation factors for industrial applications like rolling mills, cranes, winches, traction, shear press, mechanical press, power mills, textile industry, coal and mining industry.

Reference Books:

- Industrial Electronics: Chute & Chute: Electronics in Industry, Tata McGraw Hill.
- R.P. Jain: Modern Digital Electronics, Tata McGraw Hill.
- Ramamoorthy: Thyrister and Power Electronics Applications, Prentice Hall of India.
- 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.

(ME) MANUFACTURING ENGINEERING – I LABORATORY

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:

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

- Get the knowledge of working of machine tools, mechanisms and accessories used in various manufacturing processes.
- Perform the job of turning, chamfering, taper turning and threading operation using lathe.
- Perform Welding using gas/arc/ resistance welding process.

Term work:

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

Jobs:

Plain and Taper turning – one job
Thread cutting – one Job
Welding (gas or arc or resistance) – one job

Journal:

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) Machines (Any Two)
   a) Lathe,
   b) Universal milling machine,
   c) Radial drilling machine,
   d) Cylindrical grinder.

2) Mechanisms (Any Two)
   a) Capstan & Turret lathe,
   b) Spindle arbor (assembly) drive of milling machine,
   c) Crank and slotted lever quick return drive of shaping machine,
   d) Shaper quick return mechanism.

3) Accessories (Any Two)
   a) Universal dividing head,
   b) Milling cutter.

(ME) ENGINEERING THERMODYNAMICS

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:
Students will be able to

- Apply basic laws of thermodynamics in analysis and design of thermodynamic cycles including vapor and gas power cycles, refrigeration cycles, and heat-pump.
- Use thermodynamic relations in evaluation of thermodynamic properties.
- Apply the fundamentals of conservation of mass and energy, and properties of ideal gas mixtures in design and analysis
- Enhance problem solving skills.
- Evaluate performance of air standard cycles
- Gain design skills in thermal systems and enhance written communication.

Unit 1: (5hrs)
Basic concepts and properties
Introduction, thermodynamic system, control volume, macroscopic and microscopic approaches, properties and state of a system, point and path functions, thermodynamic equilibrium, processes and cycles, quasi-static process, properties such as specific volume, pressure, temperature, zeroth law of thermodynamics, temperature scales.

Unit 2: (6hrs)
Ideal gases and vapors
Difference between gases and vapors, ideal gases, gas laws, equation of state, gas constant, universal gas constant, work and heat, definition of work, thermodynamic work, work in compressible system, work-a path function, work done during various processes, p-v diagram, definition of heat, heat transfer a path function, comparison of heat and work, Phase change process of a pure substance: specific heats, sensible heat and latent heat, triple point, critical point, superheat and total heat of steam.

Unit 3: (6hrs)
First law of thermodynamics
Energy of systems, classification of energy, law of conservation of energy, first law applied to closed system undergoing a cycle, Joule experiment, energy-a property of system, internal energy: a function of temperature, enthalpy, specific heat at constant volume and constant

pressure, change in internal energy and heat transfer during various non-flow processes. First law applied to flow processes: steady state steady flow process, mass balance and energy balance in steady flow process, steady flow energy equation and its application to nozzles and diffusers, throttling valve, turbines and compressors, pumps, heat exchangers etc. Work done and heat transfer during steady flow processes.

Unit 4: (7hrs)

Second law of thermodynamics

Limitations of first law, heat engines, refrigerators and heat pumps, Kelvin-plank and Clausius statements, their equivalence, reversible and irreversible processes, factors that render processes irreversible, Carnot cycle, two propositions regarding the efficiency of Carnot cycles, the thermodynamic temperature scale, reversed Carnot cycle, COP of heat pump and refrigeration. Thermodynamic processes – constant volume, isothermal, adiabatic, polytropic processes, throttling and free expansion- p-v and T-s diagrams-work done, heat exchanged, change in internal energy.

Unit 5: (6hrs)

Entropy

Inequality of Clausius, entropy: a property of system, entropy change for ideal gases, entropy change of a system during irreversible process, lost work, principle of increase of entropy. Availability and irreversibility: available energy referred to cycle, decrease in available energy with heat transfer through a finite temperature differences. T-ds equations, Availability in a steady flow system, irreversibility and effectiveness.

Unit 6: (8hrs)

Power cycles: Gas power cycles

Otto cycle, Diesel cycle, semi-Diesel, Sterling cycles, their efficiency and mean effective pressure calculations. Vapors power cycles: Properties of steam, specific volume and entropy of steam, dryness fraction of steam, throttling of steam, determination of dryness fraction, steam tables and their use, T-s and H-s diagram, Rankine and modified Rankine cycle, work done and efficiency, specific steam consumption, comparison of Rankine and Carnot cycle, representation on P-v, T-s and h-s diagram.

Text Books

- Thermodynamics: An Engineering Approach, 3rd Edition, YunusÇengel and Michael, Boles, Tata McGraw Hill.
- Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill.

Reference Books

- Fundamentals of Thermodynamics, 5th Edition, Richard E. Songtag, Claus Borgnakke and Gordon J. Van Wylen, John Wiley and Sons, Inc.
- Thermodynamics, 4th Edition, J.P. Holman, McGraw-Hill.Engineering Thermodynamics, 2nd Edition, Jones J.B. and Hawkins G.A., John Wyley and Sons.
- Fundamentals of Engineering Thermodynamics, Moran M.S. and Shapiro H.N., John Wyley andSons, 1988.
- Thermodynamics, 5th Edition, K. Wark, McGraw-Hill

(ME) MACHINE DRAWING AND COMPUTER GRAPHICS

Teaching Scheme
Lectures : 2 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:

Students will be able to

- Demonstrate the knowledge of various ISO standards production drawing practices.
- Develop and interpret production drawings using various standards, symbols, tolerances, limits and fits.
- Effectively communicate drawing using software like AutoCAD and AutoLISP.

Unit 1: **(6hrs)**

Introduction to Machine Drawing

Types of Drawings, Production Drawing, Assembly and part drawings, Blue print reading, Study and preparation of bill of materials. Dimensioning Techniques, Representation of all types of standard components, Riveted & Welded Joints, Locking Arrangements. Conventional representation of piping layouts, pipe fittings, valves, joints. Stuffing box & glands, Expansion joints.

Unit 2: **(6hrs)**

Limits, Fits and Tolerances

ISO system of tolerance, Tolerance charts, Hole - base and shaft -base system of tolerance, Types of fits, symbols and applications, values related to various manufacturing processes.

Unit 3: **(6hrs)**

Geometric Tolerances and Surface Roughness

Geometric Tolerances:Introduction, Nomenclature, Rules, Symbols, datums and applications of Geometric Tolerances, Max & Min Material principles, Positional Tolerancing.

Surface Roughness & ProductionDrawing: Surface Textures, Roughness values and Roughness Grades, Machining symbols Conventional Representation on part drawings.

Unit 4: **(4hrs)**

Basic Drafting commands

Drawing basic entities, Modify commands, Edit commands … etc , Layers , Block attributes, Viewers, Design center utilities , Solid Modelling – Part Modeling& Assembly Modeling , Editing of solids, 3-D operations such as shading and rendering etc.

Unit 5: **(4hrs)**

Introduction to CAD programming

Concept of parametric programming, Need and importance of CAD programming. Data types: Integers, Real numbers, Strings, Symbols, Lists and File Descriptors. Data types conversions: Integer to real, string list, real to integer, string lists. Reading and writing to the screen by using visual lisp consoles.

Unit 6: **(6hrs)**

Functions and Tools of CAD Programming

Inputs in CAD Programming: Get functions for user input. Use of lists and the entities: Filtering from lists, editing/ modifying the lists, entity managing and modifying the entities. Arithmetic and Logical Functions: Additions, Subtraction, Multiplication, Division, sorting the data for deciding maximum and minimum numbers, remainders, exponential operation, trigonometric functions, AND, OR etc. Decision-making and looping, File handling functions (changing the properties of AutoCAD entities). Block attributes and extracting the attribute data.

Text Books:

- K. L. Narayana, P. Kanniah, & K.V. Reddy, “Machine Drawing ”, SciTech Publications (India Pvt. Ltd.) Chennai

Reference Books:

- IS Code: SP 46 – 1988, Standard Drawing Practices for Engineering Institutes
- Auto CAD &Autolisp Manuals by AutoDesk Corp., USA
- “Design Data”, Faculty of Mechanical Engineering, PSG College of Tech, Coimbatore

- N.D.Bhatt and P.Kanniah, “Machine Drawing”, Charotar Pub. House, Anand, Gujrath
- S. Trymbaka Murthy, “Computer Aided Engineering Drawing”, I.K. International Publishing House Pvt. Ltd, Pune

(ME) MANUFACTURING ENGINEERING – I

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Assignments /Quiz:40 marks
End Sem. Exam: 60 marks

Course Outcomes:
Students should be able to

- Identify and explain the function of the basic components of machine tools and its accessories
- Analyse various machining processes and select the particular manufacturing process for a given job.
- Have the knowledge of casting and forming process and solve the casting and forming problems.
- Explain various surface treatment processes and its engineering applications.

Unit 1: (8hrs)
Hot and cold working of metals
Principles ofrolling, forging, drop, press, upset, roll forging, extrusion, drawing, spinning, and effect of hot working. Cold working processes**,** Cold rolling, swaging, forging, extrusion- forward, backwardand impact roll forming, tube drawing, wire drawing, spinning, shot penning, high energy rate forming, sheet metal working, types of presses, drives, different operations and types of dies, Forging design**.**

Unit 2: (6hrs)
Joining processes
Arc welding- Theory, SMAW, GTAW, GMAW, FCAW, Submerged arc welding, Stud welding Resistance welding- Theory, spot and seam projection welding processes Gas welding Friction welding, Ultrasonic welding, Thermit welding, EBW and LASER welding Use of adhesive for joining, classification of adhesives, types of adhesive and their application, surface preparation and various joints welding defects and quality.

Unit 3: (8hrs)
Foundry- Pattern making, moulding and casting
Sand casting, types of pattern material, pattern making allowances, core print moulding, sand properties and testing, hand and machine moulding, core boxes, core making, melting and pouring, melting furnaces- Cupola, electric arc and induction furnaces. Cleaning, finishing and heat treatment of casting, defects in casting, shell moulding and investment casting. Permanent mould dies casting- Die-casting, low-pressure permanent mould casting, hot and cold chamber processing, centrifugal casting, semi centrifugal casting and continuous casting.

Unit 4: (8hrs)
Turning, drilling and reaming
Turning and boring, lathe construction, accessories and operations. Thread cutting- single and multi-start threading, concept of speed, feed and depth of cut. Capstan and Turret lathe. Fundamentals of drilling processes, drill geometry, types of drilling machines, operations performed on drilling machines, type of drill. Reaming processes and reamer types.

Unit 5: (7hrs)
Milling, shaping and planning

Fundamental aspects, cutter types and geometry, Operations performed on milling machine, dividing head method of indexing. Construction, working and operations performed on shaper, planer, and broaching machines.

Unit 6: **(5hrs)**

Grinding

Grinding wheels, wheel marking, wheel selection, wheel mounting and types of grinding machines. Honing, lapping, super finishing, buffing and burnishing processes.

Text Books:

- Chapman W.A.-"Workshop Technology, Vol. II, III, & I", Edward Arnold Pub.Ltd. London
- HajraChaudhary S.K.- Elements of Workshop Technology, Vol. I& II, Media Prom & Pub, Mumbai.

Reference Books:

- HMT Hand book- Production Technology
- Roy A. &Linberg- "Processes and materials of manufacturing", Prentice Hall of India Delhi.
- Campbell J.S.: Principles of manufacturing Materials and Processes, McGraw-Hill, New York.
- Begeman - "Manufacturing processes", Asia Publishing house Bombay.

(CE)STRENGTH OF MATERIALS

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:

Students should be able to:

- Apply basic concepts in mechanics to solve various problems.
- Determine the types of stresses developed in statically determinate member due to different actions.
- Analyze various problems in engineering applications subjected to various actions.

Unit 1: **(7hrs)**

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: **(7hrs)**

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 modulus calculations.

Unit 3: (6hrs)

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 and strains in determinate and indeterminate shafts of hollow, solid, homogeneous circular cross section subjected to twisting moments, stresses due to combine torsion, bending.

Unit 4: (6hrs)

a. Principal stresses and principal strain

Normal and shear stresses on any oblique planes and concept of principal planes and principal stresses 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: (5hrs)

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

Unit 6: (5hrs)

a. Axially loaded columns

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

b. Strain energy and impact

Concept of strain energy, derivation and use of expressions for deformation of axially loaded members under gradual sudden and impact loads.

Text Books:

- Ramamurtham Strength of Materials DhanpatRaiPublcation
- S.S. Rattan-Strength of Materials, Tata McGraw Hill Publication CO.Ltd.S

Reference Books:

- Mechanics of Materials" By R.C.Hibbeler (6th Edition) Pearson Education
- "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, McGraw Hill publication

(ME) MACHINE DRAWING AND COMPUTER GRAPHICS LABORATORY

Teaching Scheme
Practical : 4 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:
Students will be able to:

- Select appropriate limits, fits and tolerances for manufacturing of machine elements.
- Demonstrate use of surface finish, standard symbols and abbreviation on production drawing.
- Apply knowledge of production drawing for development of part and assembly drawing by manual and computer assisted drafting.

Term work:
Machine Drawing

1. One full imperial drawing sheet consisting the drawing/ sketches of representation of standard components, symbols of pipe joints, weld joints, rivet joint etc, surface finish symbols & grades, Limit, fit and tolerance related sketches.
2. One full imperial drawing sheet consisting of assembly and details of any one standard component such as valves, components of various machine tools, pumps etc.

CAD Drawing and Programmes

1.Assignment of CAD drawings

a. Simple Orthographic Views, Orthographic Projections with three views of any one simple machine component such as bracket, Bearing Housing or Cast component for Engines such as Connecting rod, Piston etc. and its' 3-D model.
b. Isometric Views of machine components
c. Part Modeling, Assembly Modeling and Automated Drafting

2.Assignments of CAD programming

1. Introductory programmes (minimum two on each) such as
   a. Programmes to draw geometric figure or their combinations with changes in the type of input required, for those figures. Such programmes should have use of arithmetic functions, data conversions, filtering from lists.
   b. Programmes to draw figures using Data type conversion involving users input data, blinking on the screen use of trigonometry for solving graphics problems etc.
2. Parametric Programming (minimum two on each) such as
   a. Program to draw a standard machine component by using decision-making and looping statement of Autolisp.
   b. Program to draw a profile, generated after getting data from user such as profile of cam, profile of gear tooth, profile of points present on moving links or mechanisms etc.
3. Programme to enhance the capacity of CAD drawing
   a. Making the File handling programmes
   b. Obtaining animation of moving parts or mechanisms
   c. Changing the Front page / display by Menu Customization Programme.
4. Innovative programmes: Innovative programme of any type, by using Autolisp environment

(CE) STRENGTH OF MATERIALS LABORATORY

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:
Students will be able to:

- Effectively utilize the knowledge obtained in theory in order to perform practical.

- Understand the effect of tensile, shearing force and can utilize the knowledge gained while tackling real life engineering problems.
- Effectively incorporate the important concepts learnt while designing components.

List of Experiments:

1. Tension test on Mild Steel and Aluminum
2. Shear test on Mild Steel and Aluminum
3. Torsion test on Mild Steel and Cast-Iron
4. Impact test on Mild Steel, Aluminum and Cast-Iron
5. Hardness test on Mild Steel, Aluminum and Cast iron
6. Bending test on Timber, Plywood and Mild Steel.

Semester IV [M-Group]

(MA) Vector Calculus and Partial Differential Equations

Teaching Scheme
Lectures : 2 hrs / week
Tutorials : 1 hr / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 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, 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.)

***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.

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 Centerof 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: (09 Hrs)

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.

(MA) Multivariate Calculus and Differential Equations

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

Teaching Scheme
Lectures : 4 hrs / week
Tutorials : 1 hr / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 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, 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.)

***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.

Unit 1: (09 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: (07 Hrs)

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

Unit 3: (07 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: **(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 5: **(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 6: **(07 Hrs)**

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

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 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.
- 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

(MLC) Professional Laws, Ethics, Values & HarmonyAudit Course

Teaching Scheme
Lectures : 1 hrs / week

Examination Scheme
Total - 100 Marks
Continuous evaluation:
Assignments/Presentations/Tes

Course Outcomes:

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: **(02 Hrs)**

Concept of Law

Understanding Essentials of a Valid Contract and the basics of contract law protecting rights and obligations

Unit 2: **(03 Hrs)**

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: **(01 Hrs)**

Professional Code of Conduct for Engineers, Relationship between Law and Ethics

Unit 4: **(02 Hrs)**

Self-Awareness

Understanding oneself and others; Johari Window- Concept, explanation, implementation

Unit 5: **(02 Hrs)**

Needs & Self

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

Unit 6: **(02 Hrs)**

Ethics and values

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

References

- Business Law- By Saroj Kumar
- Law of Contract- By Avtar Singh
- Business Law- By G K Kapoor
- 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.
- Govindarajan, M; Natarajan, G. M. &Senthilkumar, V.S. (2013). Professional Ethics & Human Values. Prentice Hall: New Delhi
- Jayshree Suresh, Raghavan B.S. (2016). Human Values & Professional Ethics: S Chand &Company.Pvt.Ltd: New Delhi.

(MT) SMART MATERIALS

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:

Student will be able to:

- Introduce students to the concept of “Smart” materials and systems.
- Inculcate knowledge of various smart materials, their fabrication and their multidisciplinary applications.

Unit 1: **(05Hrs)**

Concept of Smart Materials: Retrospective review, main notion, energy aspects of external influence, systematization and methods of smart materials description: methods of materials taxonomy, smart material model, classification of smart materials and engineering systems.

Unit 2: (05 Hrs)

Materials for electrical engineering and electronics: conductors, semiconductors, dielectrics, magnetic materials, optically active materials, materials for thermoelectric devices, smart battery materials, radio wave absorbing materials, sealing materials, heat-insulating and sound absorbing materials

Unit 3: (05 Hrs)

Structural materials: self-healing materials, heat and cold resistant materials, radiation resistant materials, corrosion-resistant materials and anti-corrosive coatings, lubricants, frictional materials, materials for operation at abnormal temperatures

Unit 4: (05 Hrs)

Materials for biological and biomedical systems: materials for implants, targeted drug delivery and tissue growth, antimicrobial materials, filters for water cleaning, biodegradable packages, active and bio-selective packages

Unit 5: (07Hrs)

Mechanics of smart materials: Object and subject of smart materials mechanics, structural and functional analysis smart materials in terms of mechanics, the materials with negative characteristics as source of smart effects in structures: Auxetics, statements and solutions of some smart materials based mechanics problems – e.g. self-healing of cracks, self-reinforcing of multimodular materials, porous materials-auxetic materials reversible transformations, self-assembling porous materials etc.

Unit 6: (03Hrs)

Smart materials and energy problem: Global energy problem, energy consumption for production of materials, technical and economic efficiency of smart materials and technical systems

Text Books:

- Smart Materials Taxonomy by Victor Goldade, Serge Shil'ko, Alexander Neverov, CRC Press, 1st Edition, 2016
- Smart Electronic Materials by Jasprit Singh, Cambridge University Press, 1st Edition, 2005
- Smart Materials Systems and MEMS: Design and Development methodologies by Vijay K. Varadan, K.J. Vinoy, S. Gopalkrishnan, John Wiley and Sons, 1st Edition, 2006

Reference Books:

- Encyclopedia of Smart Materials (Volume 1 and 2) by Mel Schwartz, John Wiley and Sons, 1st Edition, 2002
- Smaert Materials Edited by Mel Schwartz, CRC Press, 1st Edition, 2009
- Design, Fabrication Properties and Applications of Smart and Advanced Materials, Edited by XuHou, CRC Press, 1st Edition, 2016
- Smart Materials: Integrated Design, Engineering Approaches and Potential Applications, Edited by AncaFilimon, Apple Academic Press and CRC Press, 1st Edition, 2019

(ME) THEORY OF MACHINES - I

Teaching Scheme

Lectures : 3 hrs / week

Examination Scheme

Internal Test 1: 20 marks

Internal Test 2: 20 marks

End Sem. Exam: 60 marks

Course Outcomes:

Student will be able to:

- Determine kinematic analysis (Velocity, acceleration, Inertia forces) for a given of a given mechanism using analytically and graphically method.
- Demonstrate the dynamics of cams and followers, governors, and their characteristics.
- Draw inversions and determine velocity and acceleration of different mechanisms.
- Construct different types of cam profile for a given data.
- Solve and determine forces and dimensions of Spur and Helical Gear.
- Calculate speeds and study performance of various types of Gyroscope.

Unit 1: (08 Hrs)

Fundamentals of kinematics and mechanisms:

Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), Kutzbachcrieterion, Grubler's criterion, Inversion, Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions, steering gear mechanisms, Hooke's joint, Introduction to Compliant mechanism.

Unit 2: (12 Hrs)

Velocity and acceleration analysis:

Relative velocity acceleration methods, Corioli's component of acceleration, instantaneous center of Rotation method, Kennedy theorem of three center in line, body and space centrode, Klein's construction, Position analysis of links with vector and complex algebra methods, Velocity and acceleration analysis of mechanisms using vector and complex algebra methods. Synthesis of Mechanisms

Unit 3: (08 Hrs)

Static and dynamic force analysis of slider crank mechanism:

Analytical method for displacement, velocity and acceleration of slider crank mechanism, D'Alembert's principle, static and dynamic force analysis of slider crank mechanism, dynamically equivalent system, correction couple, graphical and analytical method for determination of torque on crankshaft.

Unit 4: (08 Hrs)

Theory of Gears I:

Classification of gears, Types of gears, Spur gears - terminology, fundamental law of toothed gearing, involute and cycloidal profile, conjugate action, contact ratio, minimum number of teeth, interference and under cutting. Helical gears: Nomenclatures, center distance, force analysis.

Unit 5: (06 Hrs)

Cams and followers:

Types of cams and followers, types of follower motion, velocity and acceleration diagrams, profile of cam cams with specified contours.

Unit 6: (06 Hrs)

Governor Mechanisms:

Introduction, Types- Mechanical and Electronic, Governor Effort and governor power, Controlling force analysis, sensitivity, stability, isochronisms and hunting, friction, insensitiveness

Text Books:

- Ballaney, P., "Theory if Machines and Mechanisms", 2005, ISBN 9788174091222 / 817409122X Khanna Publications

- John Hannah and Stephens, R. C., “Mechanics of Machines: Advanced Theory and Examples”, 1970, Hodder; Student international edition, ISBN 0713132329 Edward Arnold London

Reference Books:

- UickerJr, J. J., Penock G. R. and Shigley, J. E., “Theory oif Machines and Mechanisms’ 2003, Tata McGraw Hill.
- Ramamurthy V., “Mechanisms of Machines”, 3rd edition, ISBN 978-1842654569,Narosa Publishing House.
- Bevan Thomas, “The Theory of Machines”, 3rd edition, CBS publication.
- Bansal, R. K., “Theory of machines”, Laxmi Publications Pvt. Ltd, New Delhi

(ME) FLUID MECHANICS

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:
Students should be able to:

- Understand and apply the basic concepts of Fluid Mechanics.
- Derive analytical solutions to variety of simplified problems.
- Solve problems involving fluid properties: Static and kinematic.
- Derive and apply the governing equations of Fluid Dynamics.
- Apply energy equations for various Fluid systems and measuring devices.
- Apply and understand various dimensionless numbers for problems in fluid mechanics

Unit 1: (08 Hrs)

Basics with fluid statics:

Definition of fluid, fluid properties such as viscosity, vapor pressure, compressibility, surface tension, capillarity, Mach number etc, pressure at a point in the static mass of fluid, variation of pressure, Pascal’s law, pressure measurement by simple and differential manometers using manometric expression.

Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height and its application in shipping

Unit 2: (06 hrs)

Fluid Kinematics:

Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, acceleration of fluid particle, rotational & irrotational flow, path line, stream line and streak line Laplace’s equation in velocity potential and Poisson’s equation in stream function, flow net, Vorticity and Circulation.

Unit 3: (06 hrs)

Governing equations in Fluid Dynamics:

Derivation of Momentum equations using differential approach (Cartesian, polar and cylindrical coordinates), Reynolds transport theorem, Integration of Euler’s equation to obtain Bernoulli’s equation, Bernoulli’s theorem, Application of Bernoulli’s theorem such as Venturimeter, Orifice meter, pitot tube (static , dynamic and stagnation pressure) and orifices etc. Introduction to NavierStokes Equation.

Unit 4: (06 hrs)

Flow through pipes:

Reynolds's experiment, frictional loss in pipe flow, major and minor losses, HGL and TEL, flow through series and parallel pipes, Equivalent Pipe, Loss of head due to friction in a pipe with side tappings, siphon, Power Transmission, Pipe networks . Moody's Diagram.

Unit 5 **(06 hrs)**

Introduction to boundary layer: Thickness, over a plate, Equations of boundary layer, Laminar and turbulent boundary layer, introduction to flow separation of layer, and methods for control. Introduction to Forces on Submerged bodies: Drag, lift, Drag on cylinder, Development of lift in Cylinder. Dimensional homogeneity, Rayleigh's method, Buckingham's theorem. Similitude and Model analysis: similarity laws and dimensionless numbers.

Unit 6 **(06 hrs)**

Laminar flow: Hagen-Poiseuillie equation, flow through parallel plates, Couette flow.
Turbulent flow: Development in pipes, Velocity distribution in pipes, hydrodynamic smooth and rough pipe.

Text Books:

- Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr. P. N. Modi and Dr. S. M. Seth, Standard Book House .
- Text book of Fluid Mechanics and Hydraulic Machine, Dr. R. K.Bansal, Laxmi Publications, New Delhi.
- Fluid Mechanics – Fundamentals and application. YunusCengel and John Cimbala
- Introduction to Fluid Mechanics and Fluid Machines. S. K.Som, GautamBiswas and SumanCharaborty. Mc-Graw Hill Publication

Reference Books:

- Introduction to Fluid Mechanics . Fox R W, Pritchard P J, A T Mc Donald. John Wiley and Sons Publication.
- Fluid Mechanics, Frank M. White. McGraw Hill Publications.
- Engineering Fluid Mechanics, Prof K L Kumar, Chand Publication.
- Fluid Mechanics, P. K. Kundu , I. M. Kohen and David Dowling Fifth Edition Elsevier Publication.

(ME) FUNDAMENTALS OF METALLURGY

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course Outcomes:
Student will be able to:

- Demonstrate an understanding of the structure-property-processing correlation engineering materials.
- Select appropriate EV materials for various mechanical aspects.
- Suggest suitable types of steels and cast irons as per required application.
- Propose appropriate heat treatment for various metals and alloys studied for a particular application.
- Able to understand the concept of powder metallurgy and its application

Unit 1: **(06 Hrs)**

Engineering Materials

Overview of Metallic Materials: Ferrous, Non Ferrous Metals and their alloys (Al, Cu, Bearing Material: important properties and applications), Ceramics- Traditional and Engineering Ceramics, Polymers: Traditional and Special Polymers, Composites: Ceramic- Metal- Polymer

composites, Carbon nano tube composites, Nanomaterials and its importance in nanoscale (m.p., electrical conductivity, strength).

Unit 2: **(08 Hrs)**

Plain Carbon and Alloy 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, Effects of alloying elements and examples of alloy steels. Stainless steels. Tool steels and tool materials. Applications of plain carbon and alloy steels, specifications of some commonly used steels for engineering applications (e.g. En, DIN, IS etc with examples)

Unit 3: **(08 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 4: **(06 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 5: **(08 Hrs)**

Materials for EVs

Introduction to e-vehicles and their classification, Comparison with the IC Engine Technology, e-vehicles life cycle analysis and raw material availability, Economic considerations for batteries in e-vehicles, Value chain for electric car batteries, Introduction to various Li ion battery, super capacitors, fuel-cells and various battery technologies. Comparative study of energy and power density of various battery technologies. Critical Metals for electric motors: Nd, Eu, Y, Tb, Dy; rare earth magnets for electric motors, rare-earth free magnets, and their comparative studies.Structural materials for EVs: fibre reinforced composites, steels, Al etc., Materials required in charging stations

Unit 6: **(06 Hrs)**

Powder Metallurgy

Sintered structural components, Advantages and Limitations of powder metallurgy, powder manufacture, testing and characterization, Manufacturing of typical P/M products : cemented carbides, cermets, sintered carbide cutting tools, diamond impregnated tools , sintered metal friction materials and self-lubricating bearings. Introduction to hot and cold working.

Text Books:

- D. R. Askland& P. P. Phule, “Material Science & Engineering of Materials”, by 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.
- S.H. Avner, Introduction to Physical Metallurgy , Tata Mac Graw Hill, Second edition, 1997.
- Richard Folkson, Alternative fuels and advanced vehicle technologies for improved environmental performance: Towards zero carbon transportation, Woodhead Publishing, 1st Edition, 2014

- M. Ehsani, Y. Gao, S. Longo, K. Ebrahimi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, 3rd Edition, 2018

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.
- K. Bhargava and C. P. Sharma, Mechanical Behaviour and Testing of Materials, Publication PHI 2011

(ME) MANUFACTURING ENGINEERING - II

Teaching Scheme
Lectures : 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Course outcome:
Students will be able to:

- Demonstrate various non-conventional manufacturing processes and select proper process for the purpose of manufacturing.
- Develop competency for selecting appropriate machining process depending on desired output characteristics such as MRR, surface finish.
- Select proper machine tool for economic production.

Unit 1: (07 Hrs)
Sheet metal working
Introduction to sheet metal working, press-types and main parts of power press, die details and accessories, metal cutting in a punch and die set up, die details and accessories, types of dies, clearance, angular clearance, various press operations, strip layout, centre of pressure, cutting forces, methods of reducing cutting forces, Blanking die design, drawing- blank size calculations, number of draws, drawing force, Bending- Bend allowance, bending force calculations

Unit 2: (07 Hrs)
Theory of metal cutting
Mechanics of chip formation, oblique and orthogonal cutting, single point tool geometry, types of chips, cutting ratio, shear plane angle, velocities in cutting, Merchant circle, shear strain, power in cutting, cutting tool materials, cutting fluid, machinability, evaluation of machinability, optimum cutting speed, tool life, factors affecting tool life, computation of tool life.

Unit 3: (06 Hrs)
Non-conventional methods of machining
Need of nonconventional methods of machining, classification of non-conventional methods of machining, Operating principle, process parameters, advantages, disadvantages and applications of any four non-conventional methods of machining which uses different forms of energy.

Unit 4: (07 Hrs)
Jigs and fixtures
Introduction to jigs and fixtures, need, 3-2-1 principle of location, various locating devices, cavity location, redundancy in location, fool proofing, clamping devices, general guidelines for

design of jig/fixtures. Design of jig for simple component, design of milling fixture for simple component.

Unit 5:

NC, CNC, DNC (04 Hrs)

Introduction to CAD/CAM, NC-Basic components, procedure, coordinate system, motion control, applications, merits and problems, CNC-types, functions and advantages, DNC- Types, functions and advantages. Introduction to adaptive control, FMS and machining centre.

Surface treatment processes (03 Hrs)

Introduction to surface engineering, surface structure and properties, surface texture, need of surface treatment processes, various types of surface treatment processes, Introduction to any four surface treatment processes such as peening, burnishing, heat treatment etc.

Unit 6:

Broaching (03 Hrs)

Broach-geometry/elements, principle, Types of broaching machines, comparison of broaching with other processes, applications, broach design.

Gear manufacturing(03 Hrs)

Gear manufacturing by forming processes, gear generating processes such as gear shaping, hobbing, milling, hobbing, Gear finishing processes- shaving, roll finishing, grinding, lapping

Text Books:

- Chapman, “Workshop technology” Vol. I, II & III; Edward Arnold Publications Ltd. London.
- HajaraChaudhary S. K., “Workshop Technology” Vol. I & II, Media Prom & Publication, Mumbai.
- R. K. Jain, “Production Technology”; Khanna Publications
- Hoffman, “Introduction to Jigs and fixtures”, Galgotia Publishers

Reference Books:

- S. K. Basu, “Fundamentals of Tool design”, Tata Mcgraw Hill Education Private limited.
- SeropeKalpakjian& Steven R. Schmid, “Manufacturing processes for engineering materials
- HMT Hand book “Production technology”, Tata Mcgraw Hill Education Pvt. Ltd.
- S. E. Rusinoff, “Manufacturing processes”, Times India Press.
- Doyle, “Manufacturing processes and materials for engineers”, Prentice Hall of India Press

(ME) Manufacturing Engineering- II laboratory

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:

Students should be able to:

- Use different Non-Conventional processes for the given applications.
- Perform job on CNC machine by using CNC programming.
- Use manufacturing machine tools and make the given jobs.
- Design the Jigs and Fixture for the given jobs.

Term-work:

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

Part A

1. One composite job consisting of at least one spur gear to be made by each student.
2. One composite Job on CNC Lathe/Milling which includes operations like Turning, Facing, Taper Turning, Drilling etc.

Part B

1. Demonstration on different non-conventional machining set-ups to manufacture simple components.
2. Demonstrations on different surface treatment processes.

Part C

A journal consisting of:

1. Design of a jig or fixture. (No fabrication).
2. Assignments on NC/CNC Machines, Press working, Non-conventional processes, Advanced manufacturing Processes etc.

(ME)FLUID MECHANICS LABORATORY

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:

Student will be able to:

- Measure the pressure using manometers
- determine the forces experienced by the body when flow occurs around it
- carry out the velocity measurement using pitot tube
- determine the coefficient of discharge using Bernoulli's equation
- determine the friction factor for flow

Term-work:

The candidates have to carry out the experiments and the analysis of the fluid flow phenomenon through at least 8 experiments from the following

1. Measurement of viscosity using Red Wood viscometer
2. Study and demonstration of pressure measurement using manometers
3. Determination of the metacentric height of a floating body and its stability
4. Demonstration of electrical analogy method for flow measurement
5. Determination of coefficient of discharge for Venturi meter
6. Determination of coefficient of discharge for orifice meter
7. Determination of coefficient of discharge for rectangular notch
8. Demonstration of Pitot tube for velocity measurement
9. Determination of the friction factor for flow through a long circular pipe
10. Determination of pressure variation around a circular body when it is submerged in a flow

(MT) FUNDAMENTALS OF METALLURGY LABORATORY

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:

Students will be able to:

- Perform mechanical tests on metallic materials.
- Perform heat treatment on steels.
- Distinguish between microstructures of various metallic materials.

Term-work:

1. To perform hardness test on different metallic samples.
2. 2.To perform tensile test on different metallic samples.

3. To perform Impact test on different metallic samples.
4. Non-Destructive tests: Magnaflux testing, Dye penetrant testing.
5. Study and drawing of microstructures of various types' plain carbon steel.
6. To perform various types of heat treatment on plain carbon steels.
7. To study effect of heat treatment on microstructure and hardness of plain carbon steel.
8. Study and drawing of microstructures of various types cast irons.

(ME) THEORY OF MACHINES– I LABORATORY

Teaching Scheme
Practical : 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes:

- Students will demonstrate knowledge of various mechanisms in order to design and analyze mechanisms essential in mechanical engineering.
- Students will demonstrate ability towards graphically estimating velocity and acceleration.
- Students will exhibit skills towards application of principles of static and dynamics force analysis.
- Knowledge attained will comply towards successfully addressing issues relating to gears, governors, cams and followers in real life engineering problems.

List of Experiments:

1. Determination of moment of inertia of rigid bodies by bifilar/trifilar suspension methods.
2. Determination of moment of inertia of Compound pendulum.
3. Experimental verification of displacement relation for different shaft angles for single Hooke's joint.
4. To generate gear tooth profile and to study the effect of under cutting and rack shift using model.
5. To determine the characteristics curve of any two type of centrifugal governor and to find its coefficient of insensitiveness and stability.

List of Assignments:

1. Velocity and acceleration by vector and complex algebra method
2. Analytical determination of inertia forces in engine mechanisms.
3. Problem on steering gear mechanism.

List of Drawing Sheets:

1. Graphical solution to problems on velocity acceleration in mechanism by relative velocity and acceleration method including problem with Corioli's component of acceleration.
2. Velocity by instantaneous center method.
3. Klein's construction and inertia force analysis for slider cranks mechanisms.
4. To draw cam profile for various types of followers motion.