FLUID MECHANICS

Sub Code	**: 16IM/IP 32**	**IA Marks**	**: 20**
Hrs/week	**: 04**	**Exam Hours**	**: 03**
Total Lecture Hrs	**: 50**	**Exam Marks**	**: 80**

PART – A

MODULE-1

Properties of Fluids: Introduction, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation

Fluid Statics : Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid.

12 Hours

MODULE -2

Buoyancy and Fluid Kinematics:

Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of Metacentric height theoretically.

Kinematics: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration

12 Hours

PART-B

MODULE-3

Fluid Dynamics: Introduction equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation.

Fluid Flow Measurements :Venturimeter, orificemeter, pitot-tube, vertical orifice, V-Notch and rectangular notches.

07 Hours

MODULE-4

Flow through pipes : Minor losses through pipes. Darey's and Chezy's equation for loss of head due to friction in pipes. HGL andTEL(no problems).

Flow past immersed bodies : Drag, Lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness.

09 Hours

MODULE-5

Dimensional Analysis : Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude(theory and no problems)

Introduction to compressible flow : Velocity of sound in a fluid, Mach nuber, Mach cone, propogation of pressure waves in a compressible fluid.onplates.

10 Hours

TEXT BOOKS:

1. Fluid Mechanics and Fluid Power Engineering, Kumar.D.S, Kataria and Sons., 2004.
2. Fluid Mechancis by Dr. Bansal, R.K.Lakshmi Publications, 2004.

REFERENCE BOOKS:

1. Fluid Mechanics and hydraulics, Dr.Jagadishlal: Metropolitan Book Co-Ltd., 1997.
2. Fluid Mechanics (SI Units), Yunus A. Cingel John M.Oimbala. Tata MaGrawHill, 2006.
3. Fluid Mechanics by John F.Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006

Course objective

To provide the students with

1. The fundamentals of fluid mechanics, fluids and its properties.
2. An understanding of fluid statistics and hence the usage of manometers, forces on submerged bodies.
3. Study of Buoyancy, metacenter, continuity equation and different functions
4. Application of Bernoulli's equation to measure energy levels
5. Using different fluid equipment's to calculate fluid flow and using dimensional analysis to solve flow problems.
6. Understanding the phenomenon of losses during flow in pipes.
7. Study of Laminar flow and the viscous effects.
8. Evaluating the various parameters connected to flow around immersed bodies.

Course outcomes

After the completion of the course, a student will

1. examine the fundamental of fluid mechanics and fluids and apply the basic equations to find the force on submerged surfaces.
2. Calculate using known formula to calculate the center of buoyancy and find the velocity and acceleration.
3. Calculate various flow parameters using fluid flow meters and using dimension analysis to predict flow phenomena.
4. Use Euler's and Bernoulli's equations and the conservation of mass to determine velocities & pressures. Calculate frictional losses through pipes and to calculate the drag and lift, displacement, momentum and energy thickness.

BASIC THERMODYNAMICS

Sub Code: 16IM/IP 33

Hrs/ Week : 04 **Total Hrs. : 50**

Exam Hours : 03 **Int Marks : 20 Exam Marks : 80**

MODULE -1

Fundamental Concepts & Definitions: Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic ;Processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements.

Work and Heat: Definition of work and its limitations.Thermodynamic definition of work; examples, sign convention. 1**0 HOURS**

MODULE-2

Displacementwork; as a part of a system boundary, as a whole of a system boundary,expressions for displacement work in various processes through p-v diagrams.

First Law of Thermodynamics: Joules experiments, equivalence of heat andwork. Statement of the First law of thermodynamics, extension of the First law tonon - cyclic processes, energy, energy as a property, modes of energy, puresubstance; definition, two-property rule, Specific heat at constant volume,enthalpy, specific heat at constant pressure.

10 HOURS

MODULE-3

APPLICATION OF FIRST LAW OF THERMODYNAMICS:Extension of the First law to controlvolume; steady state-steady flow energy equation, important applications,analysis of unsteady processes such as film and evacuation of vessels with andwithout heat transfer.

SECOND LAW OF THERMODYNAMICS –Qualitative difference between heat & work; Cyclic heat engine; Energy Reservoirs; Kelvin-Planck statement of

the Second law of Thermodynamics; Clausius's statement of Second law of Thermodynamics; (Equivalence of two statements not included) ; **10 HOURS**

MODULE -4

Gas power cycle: Air Standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and dual cycles.

Introduction To Gas Turbine And Its Classification. **10 HOURS**

MODULE-5

I.C. Engine: Testing of two stroke and four stroke SI and CI engines for performance Related numerical problems, heat balance, Motoring Method, Willian's line method, swinging field dynamometer, Morse test.

Real Gases: Introduction. Van-der Waal's Equation of state, Van-derWaal's constants in terms of critical properties, Law of corresponding states,compressiblity factor; compressibility chart. **10 HOURS**

TEXT BOOKS:

1. **Basic Engineering Thermodynamics,** A.Venkatesh, Universities Press, 2008
2. **Basic and Applied Thermodynamics,** P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002
3. **Thermal Engineering,R.K**, Rajput, Laxmi Publication

REFERENCE BOOKS:

1. **Thermodynamics**, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
2. **Engineering Thermodynamics**, J.B.Jones and G.A.Hawkins, John Wiley and Sons..
3. **Fundamentals of Classical Thermodynamics**, G.J.VanWylen and R.E.Sonntag, Wiley Eastern.
4. **An Introduction to Thermodynamcis**, Y.V.C.Rao, Wiley Eastern, 1993,
5. **B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics,** PHI, New Delhi, 201

MECHANICAL MEASUREMENTS AND METROLOGY

Sub Code	**: 16IM/IP 34**	**IA Marks : 20**
Hrs/week	**: 04**	**Exam Hours : 03**
Total Lecture Hrs	**: 50**	**Exam Marks: 80**

PART- A

MODULE 1:

Standards of measurement: Definition and Objectives of metrology, Standards of length-International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-12), Numerical problems on building of slip gauges.

06 Hours

MODULE2:

System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS919-1963), geometrical tolerance, positional-tolerances, hole basis system, shaft basis system, classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Comparators and Angular measurement: Introduction to comparators, characteristics, classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators-principles, Zeiss ultra optimeter, electric and electronic comparators-principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Angular measurements, bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges (numericals on building of angles), clinometers.

12Hours

MODULE 3

Interferometer and screw thread, gear measurement: Interferometer, interferemetry, autocollimator. Optical flats. Terminology of screw threads, measurementof major diameter, minor diameter, pitch, angle and effective diameter of screw threadsby 2-wire and 3-wire methods, best size wire. Tool maker's microscope, gear.to.,terminology, use of gear tooth vernier caliper and micrometer.

Measurements and measurement systems: Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors.Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.

13 Hours

MODULE 4

Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters.

06 Hours

MODULE 5

Measurement of force, torque and pressure: Principle, analytical balance,platform balance, proving ring. Torque measurement, Prony brake, hydraulicdynamometer. Pressure measurements, principle, use of elastic merijbers, Bridgemangauge, Mcloed gauge, Pirani gauge.

I

Temperature and strain measurement: Resistance thermometers, thermocouple, law of thermo couple, materials used for construction, pyrometer, optical pyrometer. Strain measurements, strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement.

13 Hours

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994.

REFERENCE BOOKS:

1. **Engineering Metrology,** I.C. Gupta, DhapatRaiPublications,Delhi.
2. **Mechanical Measurements,** R.K. Jain
3. **Industrial Instrumentation,** Alsutko, Jerry. D. Faulk, Thompson Asia Pvt. Ltd.2002.
4. **Measurement Systems Applications and Design,** Ernest O. Doblin, McGraw Hill Book Co.

Mechanics of Materials

Code: 16 IM/IP 35	**Hours / week: 04**	**Total Hours: 50**
Exam hours: 03	**IA Marks: 20**	**Exam Marks: 80**

Module – 1

Simple Stress and Strain: Introduction, Stress and types, Strain, Tensile test on a mild steel bar, Hooke's Law and Poisson's ratio, Stress-Strain relation for cast iron and non-ferrous materials, Extension / Shortening of bars – uniform cross section, with cross sections varying in steps, with continuously varying cross sections (circular and rectangular), Principle of superposition, Elongation due to self weight.
Volumetric strain, expressions for volumetric strain for bars with uniform circular and rectangular cross sections, Simple shear stress and shear strain, Elastic constants (No derivation for relationship between elastic constants), Temperature stresses (excluding compound bars). Simple numerical problems on tensile test and determining change in dimensions.

[10 hours]

Module – 2

Principal stresses: Stresses in a tensile member, Stresses due to pure or simple shearing, mutually perpendicular direct stresses, Principal planes and stresses, Two-dimensional stress system, Graphical method (Mohr's circle) for plane stresses.
Thick and Thin Cylinder: Stresses in thin cylinders, change in dimensions of cylinder (diameter, length and volume). Thick cylinders - Lame's equations for radial and hoop stresses (compound cylinders and spherical shells not included).
Torsion of Circular Shafts: Introduction, Torsion equation – assumptions and derivation, Torsional rigidity / Stiffness of shafts. Power transmitted by solid and hollow circular shafts, Simple numerical problems.
Columns: Introduction, End conditions, Assumptions in deriving Euler's equations, Sign conventions for bending moments, Euler's formulas (no derivation) for axially loaded elastic long columns, Limitations of Euler's theory, Rankine's formula.

[10 hours]

Module – 3

Bending Moment and Shear Force in Beams: Introduction - types of beams, loads and reactions, Shear force and bending moment, Sign conventions, Relationship between load intensity, shear force and bending moment; Shear force and Bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.

[10 hours]

Module – 4

Bending Stresses in Beams: Moment of inertia and section modulus for different sections (I, T, rectangular, and circular – only formulas) Introduction to theory of simple bending, assumptions in simple bending theory, Bending stress equation - relationship between bending stress and radius of curvature, relationship between bending moment and radius of curvature; Moment carrying capacity of a section. Simple problems on rectangular, symmetrical I (about NA) and T sections. (composite / notched beams not included).

[10 hours]

Module – 5

Deflection of Beams: Introduction, Differential equation for deflection (flexure), Sign conventions and assumptions, Equations for deflection and slope - Double integration method and Macaulay's method for cantilever and simply supported beams for point load, uniformly distributed load, uniformly varying load, and couple.

[10 hours]

Texts:

1. Fundamentals of Strength of Materials – P N Chandramouli; PHI Learning Pvt. Ltd., 2013
2. Strength of Materials – R K Rajput; S. Chand and Company Pvt. Ltd. 2014

References:

1. Mechanics of Materials – R C Hibbeler; Pearson, Latest edition
2. Mechanics of Materials - James M Gere; Thomson Learning, Latest edition
3. Mechanics of Materials - Ferdinand Beer, Russell Johston, John Dewolf, David Mazurek; McGraw Hill Education (India) Pvt. Ltd., Latest edition

Note: Two questions of 20 marks each to be set from each module. Student is required to answer FIVE full questions choosing one question from each module. There should not be mix of questions from modules. However, questions within the module can be mixed.

Course Outcomes:

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

- Explain the fundamental concepts of stress and strain and the relationship between both through the strain -stress equations in order to solve problems for simple elastic solids.
- Determine different stresses induced in cylinders carrying fluids at a pressure.
- Explain the phenomena of torsion in circular shafts and determine the power transmitted by solid and hollow circular shafts.
- Explain the concept of buckling in columns and be able to compute buckling load using Euler's and Rankine's equations.
- Explain the concept of bending in beams and determine the shear force and bending moment in beams subjected to different types of loads.
- Explain the theory behind deflection of beams and determine the deflection amount caused by different loads.

Manufacturing Process I

CODE 16IM/IP 36 **Hrs/ Week : 03**
Total Hrs. : 50 **IA Marks: 20**
Exam Hours : 03 **Exam Marks : 80**

Course Objective:

The objective of the course is to study a broad range of manufacturing processes and be able to select a suitable process (Casting and welding) for the manufacture of a given component.

MODULE-1

CASTING PROCESS

Introduction: Concept of Manufacturing process, its importance.Classification of Manufacturing processes. Introduction to Casting process &steps involved. Varieties of components produced by casting process.Advantages & Limitations of casting process.

Patterns: Definition, functions, Materials used for pattern, various patternallowances and their importance. Classification of patterns.

Sand Moulding : Types of base sand, requirement of base sand. Moulding sand mixture ingredients for different sand mixtures. Method used for sand moulding, such as Green sand, dry sand and skin dried moulds.

Binder: Definition, Types of binder used in moulding sand.

Additives: Need, Types of additives used and their properties.**(09Hrs)**

MODULE 2

Cores: Definition, Need, Types. Method of making cores, Binders used,core sand moulding.

Concept of Gating & Risers. Principle and types.

Fettling and cleaning of castings. Basic steps, Casting defects, Causes,features and remedies.

MouldingMachines : Jolt type, Squeeze type, Jolt & Squeeze type and Sandslinger.

Special moulding Process: Study of important moulding processes, No bakemoulds, Flasklessmoulds, Sweep mould, CO_2 mould, Shell mould,Investment mould.**(08 Hrs)**

MODULE 3

Metal moulds: Gravity die-casting, Pressure die casting, Centrifugal casting,Squeeze Casting, Slush casting, Thixo-casting and Continuous CastingProcesses.

Melting Furnaces: Classification of furnaces. Constructional features &working principle of coke fired, oil fired and Gas fired pit furnace, Resistancefurnace, Coreless Induction furnace, Electric Arc Furnace, Cupola furnace.**(08Hrs)**

MODULE 4

WELDING

Welding process: Definition, Principles, Classification, Application,Advantages & limitations of welding.

Arc Welding: Principle, Metal Arc welding **(MAW)**, Flux Shielded MetalArc Welding **(FSMAW)**, Inert Gas Welding **(TIG & MIG)** Submerged ArcWelding **(SAW)** and Atomic Hydrogen Welding processes. **(AHW)**

Gas Welding: Principle, Oxy – Acetylene welding, Chemical Reaction inGas welding, Flame characteristics. Gas torch construction & working.Forward and backward welding.**(09Hrs)**

MODULE 5

Special types of welding: Resistance welding - principles, Seam welding,Butt welding, Spot welding and projection welding.Friction welding, Explosive welding, Thermit welding, Laser welding and

Electron beam welding.
Inspection Methods – Methods used for Inspection of casting and welding.Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography,Eddy current, Holography methods of Inspection.**(06Hrs)**

Course Outcomes:

On completion of project of this course, student are able to

- To understand various processes carried out in Foundry.
- To understand about ingredient of sand and types of Sand.
- To understand various specialized casting process.
- To understand the principles, advantage, application and limitation of various type of joining process.
- Able to make a Comparative study of all the joining processes such as welding, Soldering and Brazing along with metallurgical aspects and changes.

Scheme of Examination:

Two full question (with a maximum of four sub question) of twenty marks each to be set from each module. Each question should cover all content of the respective module.

- Student have to answer five full question choosing one full question from the each module.

TEXT BOOKS:

1. **"Manufacturing Process-I",** Dr.K.Radhakrishna, Sapna Book House,5th Revised Edition 2009.
2. **"Manufacturing & Technology**: Foundry Forming and Welding",P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

REFERENCE BOOKS:

1. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4th Ed.
Pearson Edu. 2006.
2. **"Manufacturing Technology**", SeropeKalpakjian, Steuen. R. Sechmid,
Pearson Education Asia, 5th Ed. 2006.

MACHINE SHOP

Sub Code	**: 16 IML/IPL 37A / 37B**	**IA Marks**	**: 20**
Hrs/week	**: 03**	**Exam Hours**	**: 03**
Total Lecture Hrs	**: 48**	**Exam Marks**	**: 80**

PART – A

Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper.

Cutting of Gear Teeth using Milling Machine.

Scheme of Examination:

One Model from Part – A	30 marks
One Model from Part – B	30 marks
Viva – Voce	20 marks
Total	**80 marks**

METALLOGRAPHY AND MATERIAL TESTING LABORATORY

Sub Code	**: 16 IML/IPL 38A/ 38B**	**IA Marks**	**: 20**
Hrs/week	**: 03**	**Exam Hours**	**: 03**
Total Lecture Hrs	**: 48**	**Exam Marks**	**: 80**

PART – A

1. Preparation of specimen for Metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.

2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.
3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
4. Non-destructive test experiments like,
   (a). Ultrasonic flaw detection
   (b). Magnetic crack detection
   (c). Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B

1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
4. Izod and Charpy Tests on M.S,C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

Scheme of Examination:

ONE question from part -A:	20 Marks
ONE question from part -B:	**40 Marks**
Viva -Voice:	20 Marks
Total:	80 Marks

COMPUTER AIDED MACHINE DRAWING

Sub Code : 16IM/IP 42 **IA Marks : 20**
Hrs/week : 04 **Exam Hours : 03**
Total Lecture Hrs: 50 **Exam Marks : 80**

MODULE 1

Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap.

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections.

Orthographic Views: Conversion of pictorial views into orthographic projections. of**simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions.Precedence of lines.

10 Hours

MODULE 2
Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.
Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

08 Hours

MODULE 3
Keys &Joints :
Parallel key, Taper key, Feather key, Gibhead key and Woodruff key
Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.

08 Hours

MODULE 4
Couplings:
Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

08 Hours

MODULE 5

(Part drawings should be given)

1. Plummer block (Pedestal Bearing)
2. Screw jack (Bottle type)
3. Machine vice

16 Hours

TEXT BOOKS:

1. **'A Primer on Computer Aided Machine Drawing-2007'**, Published by VTU, Belgaum.
2. **'Machine Drawing'**, N.D.Bhat&V.M.Panchal

REFERENCE BOOKS:

1. '**A Text Book of Computer Aided Machine Drawing**', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007
2. '**Machine Drawing'**, K.R. Gopala Krishna, Subhash Publication.
3. '**Machine Drawing with Auto CAD**', GoutamPohit&Goutham Ghosh, 1st Indian print Pearson Education, 2005
4. '**Auto CAD 2006, for engineers and designers**', Sham Tickoo. Dream tech 2005
5. '**Machine Drawing**', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata Mc GrawHill,2006

NOTE:

Internal assessment: 20 Marks

All the sheets should be drawn in the class using software. Sheet sizes should be A3/A4. All sheets must be submitted at the end of the class by taking printouts.

KINEMATICS OF MACHINES

Sub Code	**: 16IM/IP 43**	**IA Marks**	**: 20**
Hrs/week	**: 04**	**Exam Hours**	**: 03**
Total Lecture Hrs	**: 50**	**Exam Marks**	**: 80**

PART - A

MODULE 1

Introduction: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine.

Kinematic Chains and Inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

07 Hours

MODULE 2

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism.

Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism,

06 Hours

MODULE 3

Velocity and Acceleration Analysis of Mechanisms (Graphical Methods) Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

07 Hours

MODULE 4

Spur Gears: Gear terminology, law of gearing, Characteristics of involute action, Path of contact. Arc of contact, Contact ratio of spur, helical, bevel and worm gears, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Profile Modification.

Gear Trains: Simple gear trains, Compound gear trains for large speed. reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.

12 Hours

MODULE 5

Cams: Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.

08 Hours

TEXT BOOKS:

1. **"Theory of Machines",** Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
2. **"Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

REFERENCE BOOKS:

1. **"Theory of Machines & Mechanisms**", J.J. Uicker, , G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. **Mechanism and Machine theory**, Ambakar, PHI

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

Manufacturing Process II

CODE 16IM/IP 44 **Hrs/ Week : 03**
Total Hrs. : 50 **IA Marks : 20**
Exam Hours : 03 **Exam Marks : 80**

Course Objective

The objective of this course are to make student to study the fundamentals of single point cutting tool and basic machining processes in shaping, drilling, milling, grinding machine. To know the need and properties of cutting fluids and to familiarize with Non conventional manufacturing process.

Module 1

Classification of metal removal process and machines: Concept of orthogonal and oblique cuttingGeometry of single point cutting tool and tool angles, tool nomenclature. Mechanism of Chip Formation: Type of chips. Mechanics of metal cutting,Merchants circle diagram andanalysis, Ernst Merchant's solution, shear angle relationship,Tool Wear and Tool failure, tool life. Effects of cuttingparameters on tool life.Tool Failure Criteria, Taylor's Tool Life equation.**(09 Hrs)**

Module 2

Desired properties and types of cutting toolmaterials – HSS, carbides coated carbides, ceramics. Cutting fluids.Desiredproperties, types and selection.Heat generation in metal cutting, factorsaffecting heat generation.Heat distribution in tool and work piece and chip.
Turning (Lathe), Shaping Machines: Classification,constructional features of Turret and Capstan Lathe. Tool Layout, shapingMachine, Different operations on lathe, shaping machine.**(08 Hrs)**

Module 3

Drilling machines: drilling & related operations, Classification of drilling machine, constructional features and working principle of Radial, multi spindle, Gang, Deep hole and automatic drilling machine, Types of drill & drill bit nomenclature.
Milling machines: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations.
Indexing: Simple, compound, differential and angular indexing calculations.Simple problems on simple and compound indexing.**(09Hrs)**

Module 4

Grinding machines: Types of abrasives, Grain size, bonding process, gradeand structure of grinding wheels, grinding wheel types. Classification,constructional features of grinding machines (Centerless, cylindrical andsurface grinding).
Broaching process - Principle of broaching.Details of a broach.Types ofbroaching machines-constructional details.Applications.Advantages andLimitations.**(08Hrs)**

Module 5

Finishing and other Processes Lapping and Honing operations Principles, arrangement of set up and application. Super finishing process,polishing, buffing operation and application.
Non-traditional machining processes: Need for non traditional machining,Principle, equipment & operation of Laser Beam, Plasma Arc Machining,Electro Chemical Machining, Ultrasonic

Machining, Abrasive Jet Machining,Water Jet Machining, Electron Beam Machining, Electron DischargeMachining and Plasma Arc Machining.**(09Hrs)**

Course Outcomes

- To understand Tool Nomenclature, different types of machine tools , types, applications and operations
- Ability to understand failure criteria, heat generation and selection ofcutting fluids.
- To understand the tool life of different cutting tool materialsand Indexing in milling machine.
- To understand the working of shaping and grinding.
- To understand the principles, advantages, application and limitations of Non-conventional Machining.

Scheme of Examination:

- **Two full question (with a maximum of four sub question) of twenty marks each to be set from each module. Each question should cover all content of the respective module.**
- **Student has to answer five full question choosing one full question from the each module.**

Text Books:

1. Elements of Workshop Technology: Machine Tools (Volume – 2) by S. K. HajraChoudhary, A. K. HajraChoudhary, Nirjhar Roy, Media promoters (2010).
2. Manufacturing Processes for Engineering Materials, 4th Edition bySeropeKalpakjian, Steven R. Schmid, published by Pearson (2007).
3. Fundamentals of Metal Machining and Machine Tools by G. Boothroyd, McGraw Hill, 2000.

Suggested Readings

1. LalG.K.,Introduction to Machining Science, New Age international Publishers.
2. Ghosh, A., &Mallik, A. K. , Manufacturing Science, East West Press Private Limited.
3. Pandey & Singh, Production Engineering Science, Standard Publishers Distributer, Delhi.
4. Karl H.Heller, All About Machine Tools, Wiley Eastern Ltd., New Delhi
5. Sen, G. C., & Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency
6. Bhattacharyya A, Theory & Practice of Metal Cutting, New Central Book Agency
7. Trent, E. M. Metal cutting: Butterworth Heinemann
8. Stephenson, D. A., &Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis.
9. Milton C. Shaw, Metal Cutting Principles, CBS Publishers.

Materials Science and Metallurgy

Sub Code: 16IM/IP 45
Hrs/ Week : 04 **Total Hrs. : 50**
Exam Hours : 03 **IA Marks : 20 Exam Marks : 100**

Course objectives:
To make students understand how and when such imperfections are formed and what could be the effects of such imperfections on the properties of the material

To distinguish between steady and non-steady types of diffusions

To appreciate the significance and construction of phase diagrams

To construct the iron carbon equilibrium diagram and identify different phases

To understand the properties of different metals resulting from different heat treatments

MODULE- I

Crystal Structure-Unit Cells, Crystal systems, BCC, FCC, and HCP structures, Coordination number and atomic packing factors **Crystal Imperfection-**Point, line and surface imperfections **Atomic Diffusion-**Fick's laws of diffusion, Factors affecting Diffusion, Steady and non-steady state diffusions

MODULE-II

Dislocation
Characteristics of dislocations slip systems, slip in single crystals, Plastic deformation of polycrystalline materials, Deformation by twinning
Fracture
Types of fracture, ductile and brittle fracture, Ductile to brittle transition temperature **Fatigue and creep** Cyclic stresses, SN curves, crack initiation and propagation, Factors affecting fatigue life, Creep behavior Stress and temperature effects, Data extrapolation methods

MODULE-III

Phase Diagrams
Solid solutions, Hume Rothary rules-substitutional, and interstitial solid solutions, Intermediate phases, Gibbs phase rule, Construction of equilibrium diagrams, lever rule **Iron carbon equilibrium diagram** Description of phases, Solidification of steels and cast irons, Invariant reactions, TTT curves, Continuous cooling curves

MODULE- IV

Heat Treatment of Metals Annealing and its types, normalizing, Hardening, tempering, Mar-tempering, Austempering, Hardenability, surface hardening methods like carburizing, cyaniding, Nitriding, Flame hardening and induction hardening. Age hardening of Aluminium –Copper alloys **Recovery, Recrystallization and Grain Growth** Recrystallization temperature, Annealing temperature v/s cold-worked and recovered grains, Direction of grain boundary motion, time v/s grain diameter

MODULE- V

Steels and cast irons Ferrous alloys, steels – low medium and high carbon, AISI designation steels, Cast irons – types and properties **Composites and ceramics** Composite materials: definition, classification, Types of matrix materials & reinforcements, Application of composites, Ceramics: Glasses, Glass – ceramics, clay products, Refractories, abrasives and cements.

Scheme of Examination:

- **Two full question (with a maximum of four sub question) of twenty marks each to be set from each module. Each question should cover all content of the respective module.**
- **Student has to answer five full question choosing one full question from the each module.**

Course outcomes: The students should be able to

Estimate the impact of imperfection on the property of the material

Analyze steady and non-steady types of diffusion and solve related problems

Construct the iron carbon diagram and TTT curves

Estimate the hardness and other properties of metals obtained from different heat treatment processes

Select the right iron-carbon alloy for any given application

Text Books:

1. William D Callister, "An Introduction -Material's Science and Engineering", John Wiley and Sons India Pvt Ltd., 6th Edition, 2006 New Delhi.
2. Smith -Foundation of Material Science and Engineering, 3rd Edition, McGraw Hill, 1997.
3. Donald R Askland, Pradeep.p.phule -Essentials of Materials for Science and Engineering, Thomson Engineering, 4th edition 2003.

References :

1. V Raghavan -Physical Metallurgy, Principles and Practices, PHI, 2nd Edition 2006, New Delhi.
2. H. Van Black and Addison -Elements of Material Science and Engineering, Wesley Edition,1998.
3. James F Shackelford -Introduction to Material Science for Engineering, 6th edition
4. Pearson Prentice hall, New Jersey,2006.

COMPUTER AIDED DESIGN AND MANUFACTURING (CAD / CAM)

Sub Code: 16IM/IP46 IA Marks: 20
Hrs / Week: 4Hrs Exam: 3 Hrs
Total Hrs: 50 Marks: 80

MODULE 1

INTRODUCTION: Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment.Introduction to CAD, Introduction to CAM.Advantages and disadvantages of CAD and CAM.

HARDWARE IN CAD: Basic Hardware structure, working principles, usage and types of hardware for CAD - input and output Devices, memory, CPU, hardcopy and Storage devices. **12Hrs**

MODULE 2

COMPUTER GRAPHICS: Software configuration of a graphic system, function of a Graphics package, construction of geometry, wire frame and solid modelling, CAD/CAM integration. Describe modelling facilities. Introduction to exchange of modeling data – Basic features of IGES, STEP, DXF, DMIS.

NC, CNC, DNCTECHNOLOGY : NC, CNC, DNC< modes, NC elements, advantages and limitations of NC, CNC. Functions of computer in DNC. **12Hrs**

MODULE 3

CNC TOOLING: Turning tools geometry, milling tooling systems, tool presetting, ATC work holding.

CAM PROGRAMMING: Overview of different CNC machining centers, CNC turning centers, high speed machine tools, MCE. **12 Hrs.**

MODULE 4

CNC PROGRAMMING: Part program fundamentals – steps involved in development of a part program. Manual part programming, milling, turning center programming. **12 Hrs.**

MODULE 5

INTRODUCTION TO ROBOTICS : Introduction, Robot Configuration, Robot Motions, Programming the Robots, Robot- Programming Languages, End effectors, Work Cell, Control and Interlock, Robot Sensor, Robot Applications. **12 Hrs**

Text Books:

1. CAD / CAM Principles and Applications by P.N.Rao, TMH, New Delhi, 2002
2. CAD/CAM, Mikell P-groover, Emory W. ZimrnersJr Pearson Education inc, 2003

References :

1. Introduction to the Design and Analysis of Algorithms -S.E.Goodman, S.T. Headetmiemi, McGraw Hill Book Company -1988

2. Principles of Interactive Computer Graphics by Newman and Sproull, Tata McGraw Hill, 1995
3. NC Machine programming & software Design -Chno-Hwachang, Michel.A. Melkanoff, Prentice Hall, 1989.
4. Numerical control and CAM, Pressman RS and WilliamsJE, JohnWiley.
5. Computer Graphics by Steven Harrington, McGraw Hill Book Co.
6. CAD-CAM by Chris McMahon &Jimrnie Browne -Pearson education Asia 2001
7. CAD/CAM -IbrahimZeid, Tat McGraw Hill, 1999
8. Computer Aided Manufacturing by P.N.Rao, N.K.Tewari and T.K. Kundra Tata McGraw Hill 1999.
9. Introduction to FEM, T ChandraPattaAshokDBebgundu.

COURSE OBJECTIVES.

To provide the student to
1. know the fundamentals of CAD
2 information regarding various CAD hardware
3 understand the fundamentals of CAM
4 programming concepts in CNC
5 robotics and their applications

COURSE OUTCOMES

A student will be able to

1. understand the concepts of CAD and the required hardware
2 understand CAM and CNC machines
3 program CNC machines
4 Understand and program the robot

FOUNDRY AND FORGING LABORATORY

Sub Code	**: 16 IML/IPL 47A / 47B**	**IA Marks**	**: 20**
Hrs/week	**: 03**	**Exam Hours**	**: 03**
Total Lecture Hrs	**: 48**	**Exam Marks**	**: 80**

PART – A

1. Testing of Moulding sand and Core sand

Preparation of sand specimens and conduction of the following tests:

1 Compression, Shear and Tensile tests on Universal Sand Testing Machine.

2 Permeability test

3 Core hardness & Mould hardness tests.

4 Sieve Analysis to find Grain Fineness number of Base Sand

5 Clay content determination in Base Sand

PART – B

2. Foundry Practice

Use of foundry tools and other equipments.

Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).

Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

3. Forging Operations :

Calculation of length of the raw material required to do the model.

Preparing minimum three forged models involving upsetting, drawing and bending operations.

Out of these three models, at least one model is to be prepared by using Power Hammer.

Scheme of Examination:

One question is to be set from Part-A: 20 marks

One question is to be set from either

Part-B or Part-C: 40 marks

Calculation part in case of forging is made compulsory

Viva : 20 marks

MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY

Sub Code	**: 16IML/IPL 48A/ 47B**	**IA Marks**	**: 20**
Hrs/week	**: 03**	**Exam Hours**	**: 03**
Total Lecture Hrs	**: 48**	**Exam Marks**	**: 80**

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using SineCenter / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
    a. Lathe tool Dynamometer
    b. Drill tool Dynamometer.
5. Measurement of Screw thread Parameters using Two wire or Three-wire method.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

Scheme of Examination:

ONE question from Part -A	30 Marks
ONE question from Instrumentation Part -B	30 Marks
Viva –Voce	20 Marks
Total	**80 Marks**