



**Mandsaur University, Mandsaur**  
**MhowNeemuch By-Pass Road, Sh. 31, Mandsaur 458001 (M.P.)**  
**Syllabus of Examination w.e.f. (Session 2017-18)**  
**Mechanical Engineering Diploma(03YDC)**  
**Professional Activity-II (MEC370)**

## **SEMESTER: III**

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### **RATIONALE:**

Professional Activities consists of a group of open- ended activities where in variety of tasks are to be performed, to achieve specific objectives. The general guidelines for achieving the target and procedure for achieving the completion of the task are given below.

### **OBJECTIVES:**

- To inculcate the overall professional development of students to cope up with the demand engineering profession.
- To provide time for organization of student chapter activities of professional Organization Institute of engineers, ISTE
- To plan the development of abilities in students for leadership and public speaking through organization of student's seminar.
- To provide time for organization of guest lectures by expert engineers/eminent professionals of industry.
- To provide time for organization of technical quiz or group discussion or any other group activity.
- To provide time for visiting library or using Internet.

### **DETAILED INSTRUCTIONS TO CONDUCT PROFESSIONAL ACTIVITIES**

- (i). Study hours, if possible should be given greater time slot with a minimum of two hrs/week to a maximum of four hrs/week.
  - (ii) This course should be evaluated on the basis of grades and mark sheet of students, should have a separate mention of the grade awarded. There will be no pass/fail in professional activities (PA).
  - (iii). Assessment of performance in PA is to be done internally by the Institution, twice in a Semester/Term through a simultaneous evaluation of the candidate by a group of three teachers, of the deptt. Concerned. Group of teachers will jointly award the grade to candidate in the assessment. Best of the grades obtained by the student in these two assessments shall be finally taken on the mark sheet of the respective Semester/Term. Candidate abstaining from the prescribed course work and/or assessment planned at the Institute shall be marked ABSENT in the mark sheet, instead of any grade.
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**SEMESTER: III**

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**Course objective:**

1. Purpose of this subject is to introduce basic manufacturing concept.
2. This subject is to understand manufacturing technique like: metal casting, pattern making, moulding, press working, forging etc.

**UNIT-I**

**Introduction to Manufacturing Processes:** Basic Manufacturing Processes i.e, Mechanical Working, Casting, Metal Joining Processes, Metal Cutting Process, Press Working . Examples of Each of the Above Listed Manufacturing Processes, Factors Which Influence Selection of Manufacturing Process for a Particular Application.

**Metal Casting :** Introduction , Advantages and Limitations of Casting as Production Process.

**Pattern Making :** Definition of Pattern, Types of Patterns and Their Details, Materials, Allowances, Tools Required, Colour Code for Patterns.

**UNIT-II**

**Moulding :** Definition, Moulding Methods and Types of Moulds, Moulding Materials, Moulding Sand and Its Composition, Sand Properties, Testing Parameters of Sand, and Their Effects, Sand Preparations, Sand Conditioning, Characteristics and Defects of Moulds. Function of Runners, Risers and Gate. Cores and Core Making, Core Boxes. Cleaning of Casting, Special Casting Methods, Need for Special Casting Methods, Die Casting, Centrifugal Casting, Investment (Lost Wax) Casting, Casting Defects, Causes and Analysis, Area of Application of Casting Process.

**Furnaces :** Cupola ,Crucible, Pit and Electric arc Furnaces, Induction Furnace , Their Salient Features, Safety Aspects.

**UNIT-III**

**Press Working :** Introduction of Press Working of Metals, Principle of Press Working , Description of a Simple Press Working Unit, Press Operations : Punching, Shearing, Drawing, Bending, Slitting, knurling, Notching, Trimming, Piercing etc. Die and Punch, Types of Dies, Specifications of a Press, Safety Precautions to be Observed While Working on a Press.

**Mechanical Working:** Introduction - Hot and Cold Working Principle of Recrystallization.

**UNIT-IV**

**Forging :** Types of Forging, Die Forging, Differentiate Between the Die and Hot Die Forging, Advantage of Forming by Forging, Common Defects and Their Reasons. Limitations of Forging, Press Forging, Drop Forging, Upset Forging, Die Material, Applications of Forging Processes in Engineering.

**Metal Rolling :** Principle of Metal Rolling , Basic Components of a Simple Rolling Process Equipment.

**Extrusion :** Definition, Classify the Methods of Extrusion, Their Limitations, Advantage and Disadvantage.

**UNIT-V**

**Metal Joining :** Introduction, Classification of Metal Joining Processes

**Welding :-**Classification, Plastic, Fusion and Forge Welding, Weldability of Metals, Metallurgy of Welding.

**Gas Welding and Gas Cutting :** Principle of Operation and Technique, Gas Cutting.

**Arc Welding** : A.C. and D.C arc Welding, MIG,TIG, Submerged arc , Atomic Hydrogen, Electro-Slag, Plasma Arc Welding Processes, Electrodes- Types and Selection , Flux and Their Uses. Special Welding Techniques- Welding of Different Metals. Defects in Welds, Testing and Inspection. Accident Prevention in Gas and Arc Welding Equipments & Tools Used in Metal Arc Welding, Specification and Functions. Soldering, Brazing and Adhesive Bonding.

**OUTCOME:**

student will have a broad knowledge of sand casting: Pattern making: requirement of pattern materials, different pattern materials and designing of the pattern; Moulding and core making: Moulding sand, sand conditioning, moulding and core making processes and machines and special moulding methods; permanent mould casting: requirement of permanent mould casting, design requirement of permanent moulds and types of permanent mould casting; designing of gating system and risers, cupola furnace and defects in metal casting.

**LIST OF EXPERIMENTS (Expandable)**

1. Making a Split/Solid Pattern from Wood in Carpenry Shop.
2. Making a Core Box in Carpentry Shop.
3. To Study of Green and Dry Sand Making in Moulding Shop.
4. Practice of Open Mould in a Two Boxes, Using Single/Split Pattern in Moulding Shop
5. Practice of Metal Forming in Smithy Shop.
6. Making a Square Bar Out of a Given Round Bar in Black Smithy Shop.
7. Making of a Chisel in Black Smithy Shop.
8. Practice of Edge Preparation for Welding in Fitting Shop.
9. Practice of A.C. Arc Welding of Corner and Edge Joint.
10. Practice of Making Gas Flames with Nozzles.
11. Practice of Gas Welding Joints.
12. Practice of Gas Cutting Operation.
13. Practice of D.C. Welding Operation.
14. Practice of Metal Inert Gas (MIG)Welding Operation.

**REFEREES**

1. Process And Materials of Manufacture -by Lindberg.
2. Workshop Technology -by Hazara & Choudhary.
3. Materials And Manufacturing Process - by Dalela.
4. Production Engineering – P.C. Sharma
5. Manufacturing Technology - P.N. Rao
6. Production Technology - R.K. Jain

**TEXT BOOKS**

1. Foundry Engineering -by P.L. jain.
2. Nirman Prakram ( Hindi) - by P.N. Vijayvargiy  
( Deepak Prakashan, Morar, Gwalior



**SEMESTER: III**

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**COURSE OBJECTIVE:**

1. Students have an ability to apply knowledge of Modeling, science & engineering.
2. Student can modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.
3. Students will able to demonstrate an ability to design and conduct experiments, analyze and interpret data and assembly and disassembly drawings knowledge will be provided.

**UNIT 1:** Introduction to BIS Specification SP: 46 – 1988 Code of Engineering Drawing – Limits, Fits and Tolerance (Dimensional and Geometrical Tolerance), Surface Finish, Surface Roughness: Roughness and Machining Symbols, Indication on Drawings. Representation of Machine Parts Such as External and Internal Threads, Slotted Heads, Square Ends, and Flat Radial Ribs, Slotted Shaft, Splined Shafts, Bearings, Springs, Gears. Rivet Heads and Riveted Joints, Types of Welded Joints and Representation, Orthographic Views from Isometric Views of Machine Parts.

**UNIT 2 :** Dimensioning, Practical Significance of Dimensioning, Types of Dimensioning, Rules of Dimensioning, Chain and Progressive Aligned System and Unidirectional System of Dimensioning, Sectioning ,Various Types of Sections : Full Section, Half Section, Removed and Revolved Section, Auxiliary, Sectioning Conventions. Elements of Production Drawing, Limits, Fits and Tolerance, Allocation of Fits for Various Mating Parts, Tolerance Data Sheet, and Tolerance Table Preparation, Geometric Tolerance.

**UNIT 3 :** Assembly Machine Drawing: Basic, Plotting Technique, Assembly Drawing with Sectioning and Bill of Materials from Given Detailed Drawings, Assembly Drawing Exercises of : Cotter and Knuckle Joints, Pedestal and Footstep Bearings, Plummer Block, Crosshead, Stuffing Box, Eccentrics, IC Engines Parts - Piston and Connecting Rods; Lath Machine Parts: Tailstock.

**UNIT 4 :** (AutoCAD): Introduction to Auto CAD, Starting with AutoCAD, AutoCAD Dialog Boxes, Co-ordinate Systems, Drawing Lines, Circle, Arcs, Rectangle, Ellipse, Polygons, etc. Use of Editing Commands : Editing Technique Employed on Objects and Sketches, Applications of Various Commands in the Preparation of Machine Drawings in AutoCAD : Moving, Copying, Pasting, Offsetting, Scaling, Chamfering, Trimming, Mirroring. Filletting, Sketched Objects. Basic Principles and Techniques in Dimensioning: Geometric Dimensioning and Tolerance: Dimensioning AutoCAD, Creating Linear, Rotated, Angular Aligned Base Line Dimensions. the Drawings in AutoCAD, Plotting Drawing.

**Outcome:**

Analysis of complex design systems related to mechanical Engineering. Making use of appropriate laboratory tools and design innovative methods. To motivate students to develop new innovative methods for measuring product. Characteristics. To enhance the ability of students to work as teams.

**References:**

1. Narayana and Reddy; Machine Drawing; New age, Delhi.
2. Singh A; Machine Drawing; TMH
3. Bhat, ND; Machine Drawing; Charotar
4. Agarwal and Agrawal; Engineering Drawing; TMH
5. John KC; Text Book Of Machine Drawing; PHI Learning

**List of Experiments (Expandable):**

S.No.	Name of Experiment
1	To Prepare Drawing Sheet on Types of Lines & Their Applications in Engineering Drawing
2	Significance of Dimensioning Patterns in Technical Drawings
3	Engineering Applications of Tolerances, Allowances and Systems of Limits & Fits
4	Study of Representation of Machine Component Parts by Suitable Symbols in Machine Drawing
5	Study of different Types of Sectional Views Used in Machine Drawings
6	Assembly Drawing of Knuckle Joint
7	Assembly Drawing of Cotter Joint (i)Socket & Spigot Joint (ii)Cotter Joint with Sleeve (iii) Gib and Cotter Joint
8	Assembly Drawing of Pedestal Bearing (Plummer Block)
9	Assembly Drawing of Cross Head (A Steam Engine Component Part)
10	Assembly Drawing of Connecting Rod (For Steam Engine & I.C. Engine )
11	Assembly Drawing of Tail stock (Lathe Machine Part)
12	Assembly Drawing of Tool Post (Shaper Machine)
13	Assembly Drawing of Riveted Joints
14	Assembly Drawing of Welded Joints
15	Assembly Drawing of Screw Jack
16	Introduction to Basic Commands and Their Use in Auto CAD



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**Syllabus of Examination w.e.f. (Session 2017-18)**  
**Mechanical Engineering Diploma(03YDC)**  
**Measurement & Control ME350**

**SEMESTER:III**

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**COURSE OBJECTIVE:**

1. Develop ability to set up measurement systems with a control environment.
2. Develop an ability to design and utilize advanced control systems.
3. To provide essential elements of electrical circuit analysis with a definite focus on Mechanical Engineering application.
4. To provide an introduction to instrumentation and devices used for measurements in electromechanical systems and introduction to automatic control systems.

**UNIT I: RATIONALE** The Art of Measurement Plays an Important Role in all Branches of Engineering. With Advances in Technology, Measurement Techniques have also Taken Rapid Strides, with many Types of Instrumentation Devices, Innovations, Refinements. The Course Aims at Making a Mechanical Engineering Student Familiar with the Principles of Instrumentation, Transducers & Measurement of Non Electrical Parameters Like Temperature, Pressure, Flow, Speed, Force and Stress and Methods of Control Systems for Engineering Applications..

**UNIT II: Generalized Measurement System:** Introduction - Introduction to Measurement and Measuring Instruments, Generalized Measuring System and Functional Elements, Units of Measurement, Static and Dynamic Performance Characteristics of Measurement Devices, Calibration, Concept of Error, Sources of Error, Statistical Analysis of Errors Sensors and Transducers – Types of Sensors, Type of Transducers and Their Characteristics

**UNIT III: Measurement:** Measurement of Displacement and Angular Velocity. Measurement of Pressure: Gravitational Direct Acting, Elastic and Indirect Type Pressure Transducers. Measurement of Very Low Pressure–McLeod Gauge and Pirani Gauge. Measurement of Temperature: Measurement of Temperature by Thermometers, Bimetallic, Thermocouples, Thermistors and Pyrometers-Total Radiation and Optical Pyrometry, Thermocouples, RTDs, Pyrometers, Pyrometric Cones. Measurement of Strain: Type of Strain Gauges and Their Working, Strain Gauge Circuits, McLeod Gauge, Pirani Gauge, Temperature Compensation. Strain Rosettes, Analysis of Strains, Measurement of Force and Torque

Statistics: Least Square Regression and Data Outlier Detection; Normal Distribution and Concept of Standard Deviation of the Mean in Finite data Set, Uncertainty Analysis: Measurement Errors; Error Sources: Calibration, Data Acquisition, Data Reduction; Design Stage Uncertainty Analysis; Combining Elemental Errors; Bias & Precision Errors; Error Propagation, Higher Order Uncertainty Analysis.

**UNIT IV: Metrology:** Standards of Measurement, Linear and Angular Measurement Devices and Systems Limit Gauges, Gauge Blocks. Measurement of Geometric Forms like Straightness, Flatness, Roundness and Circularity, Principles and Application of Optical Projectors, Tool

Makers, Microscope, Autocollimators etc. Principle and Use of Interferometers, Comparators, Measurement of Screw Threads and Gears, Surface Texture Measurement

**UNIT V: Control systems:** Block Diagram of Automatic Control System, Closed Loop System, Open Loop System, Feedback Control System, Feed Forward Control System, Servomotor Mechanism, Comparison of Hydraulic, Pneumatic, Electronic Control Systems, and Proportional Control Action. Applications of Measurements and Control for Setup for Boilers, Air Conditioners, Motor Speed Control.

**OUTCOME:**

An understanding of, and an ability to analyze and select electric circuit components including current and voltage sources, resistance, inductance, capacitance, and operational amplifier. An understanding of and an ability to apply analytical and computer-aided methods for solution of electrical circuits. An understanding of basic measuring devices including transformers, transducers, and pressure, flow rate, and temperature measurement devices. Methods for rating instrument devices including dynamic range, resolution, accuracy and precision, bandwidth.

**List of Experiment(Expandable):**

1. Measurement of Temperature by Using Thermocouple.
2. Measuring Velocity of Fluid Flow by Orifice Meter/ Pitot-tube..
3. Measurement of Various Parameters of Different Objects Using Gauge Block,
4. Measuring Velocity of Fluid Flow by Venturi Meter
5. To Study of LVDT
6. Study of Various Pressure Measuring Devices like Manometers, Mercury in Glass Pressure Gauge.
7. Measurement of Various Parameters of Different Objects Using Vernier Caliper.
8. Study of Indian Standards IS: 919 Recommended for Limit and Fits.
9. Study of Micrometer and its Uses in Various Measurement Methods.
10. Measurement of Various Parameters of Different Objects Using Micrometer.
11. Study of Various Force Measuring Instruments.
12. Study of Servomotor Mechanism.

**REFERENCES**

1. Engineering Metrology. by R.K. Jain
2. Mechanical Measurements & Control; D.S.Kumar
3. Metrology and Instrumentation; Swahney
4. Mechanical Measurement; Thomas Beckwith
5. Instrumentation for Engg. Measurement; James W Dally



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**Syllabus of Examination w.e.f. (Session 2017-18)**  
**Mechanical Engineering Diploma(03YDC)**  
**Mechanics of Materials (MEC-360)**

**SEMESTER: III**

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**COURSE OBJECTIVE:**

The objective of this course is elaborate on the knowledge of engineering mechanics (statics) and to teach the students the purpose of studying strength of materials with respect to engineering design and analysis. The course introduces the students to the concepts of engineering mechanics of materials and the behaviour of the materials and structures under applied loads.

**UNIT 1.** Simple Stress and Strains : Introduction Types of Loads and Deformation, Types of Stresses and Strain. Hooke's law, Stress Strain Diagram for Ferrous and Non Ferrous Materials Modulus of Elasticity. Rigidity and Bulk Modules of Materials Stress in Bars of Varying Cross Sections, Composite Sections and Compound Sections Thermal Stresses and Strains, Thermal Stresses in Composite Sections. Poisson's Ratio, Volumetric Strain, Relation Between Different Modulus, Strain Energy, Resilience, Proof Resilience, Modules of Resilience Suddenly Applied Loads and Impact Loads. Principal Planes and Principal Stresses: Stresses on Inclined Plane Subjected to Direct Shear or Combination of Stresses in Two Mutually Perpendicular Planes. Principal Planes and Principal Stresses Analytical Methods.

**UNIT 2.** S.F. and B.M. Diagrams : Definition, Types of Loading Types of Beams, Shear Force and Bending Moment Sign Conventions S.F. and B.M. Diagrams for Cantilever Simply Supported and Overhanging Beams with Point or Concentrated Loads Uniformly Distributed Loads and Combination of Point and U.D.L. Point of Contra Flexure.

Bending Stresses in Beams : Theory of Simple Bending as Assumptions Made in Simple Bending Theory Position of Neutral Axis, Surface Moment or Resistance. Modules of Section of Symmetrical Sections Such as Rectangular, Circular and I Sections, Bending Stresses in Symmetrical Sections. Shear Stresses in Beams.: Introduction Shear Stress Equation, Assumptions Made, Distribution of Shear Stresses Over Various Sections, Such as Rectangular, Circular and I, L & T Sections.,

**UNIT 3.** Deflection of Beams : Introduction Strength and Stiffness of Beam, Curvature of Bent Beam, Derivation of Equation for Slope and Deflection of Beam in Case of Cantilever and Simply Supported Beam Loaded with Point Loads U.D.L. and Combination.

Torsion of Shaft : Definition of Torsion Relation Between Stress, Strain and Angle of Twist Assumptions Made Strength of Solid and Hollow Circular Shaft, Polar Moment of Inertia. Calculation of Shaft Diameter on the Basis of Strength and Stiffness for the Given Horse Power Transmitted Torsional Rigidity.

**UNIT 4.** Spring : Definition Types and Use of Springs, Leaf Spring, Helical and Spiral Springs, Stiffness of a Spring and Maximum Shear Stress, Deflection of Spring . Spring Classification Based on Size Shape and Load.

Stresses in Frames : Definition of Frame, Perfect, Deficient and Redundant Frame. Assumptions Made in Finding Stress in Method of Sections. Joint Method.

**UNIT 5.** Columns and Struts :Definitions Crippling Load Different end Conditions, Slenderness Ratio, Equivalent Length, Euler's Theory Rankine's Formulae, Radius of Gyration, Rankine Constant for Different Materials Limitations of Rankine Formula Simple Problem B.I.S. Code for Columns.

**Outcome:**



Objective of the course will be to show how to determine the stress, strain, and deflection suffered by bi-dimensional structural elements when subjected to different loads (e.g. normal, shear, torsion, bending and combined loads). Once the state of stresses and strains has been established for a particular structure type, the student will be able to evaluate the allowable loads and associated allowable stresses before mechanical failure. Understanding the adequacy of mechanical and structural elements under different loads is essential for the design and safe evaluation of any kind of structure.

**References:**

- Rattan; Strength of Materials; TMH
- Sadhu Singh; Strength of Materials; Khanna Pub.
- Dr. B.C.Punamia, A.K. Jain, Mechanics of Materials, Laxmi Publication (P) Ltd.
- R.K. Bansal, Strength of Materials, Laxmi Publication (P) Ltd.
- RK. Rajput, Strength of Materials, S. Chand Publication
- पदार्थों की यांत्रिकी , पुण्डीर, Nano Edge Publications.
- Laboratory Experiments In Strength of Materials by B.D. Sharma
- Dravya Samarthya (Hindi) by K. D. Saxena (Deepak Prakashan, Morar Gwalior)

**List of experiments(Expandable):**

- 1 To Study of Universal Testing Machine (UTM)
- 2 To Perform Standard Test on MS and CI Test Specimen
- 3 To Perform Standard Compressive Test on Mild Steel and Cast Iron Specimen
- 4 To Perform Transverse Bending Test on Wooden Beams to Obtain of Rupture
- 5 To Study of Fatigue Test
- 6 To Perform Brinell Hardness Tests
- 7 To Perform Vicker Hardness Test
- 8 To Perform Izod Impact Test
- 9 To Perform Charpy Impact Test
- 10 To Perform Direct/ Cross Shear Test on MS and CI Specimen
- 11 To Study of Torsion Testing Machine

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**Mechanical Engineering Diploma(03YDC)**  
**Engineering Metallurgy (MEC320)**

**SEMESTER: III**

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**COURSE OBJECTIVE:**

1. Understand structure-properties relationship.
2. Manipulate atomic/microstructural processes to create desired structure & processes to create desired structure & properties.

**Unit I : Introduction:** Mechanical Properties of Metals, Extraction of Non-Ferrous Metals, Basic Principles Involved in the Extraction Process of Copper, Aluminium, Lead, Zinc, Nickel, Tin, Magnesium. Production of Iron and Steel, Production of Pig Iron, Wrought Iron, Production of Steel.

**Unit II : Crystal Structure & Solid Solutions:** Crystal , Space Lattice or Crystal Lattice and Unit Cell, Crystal Structure of Metals (B.C.C., F.C.C. and H.C.P) , Classification Amorphous and Crystalline States, Allotropy. Miller Indices. Crystal Imperfection and their Effects on Properties.

**Solidification of Metal and Ingot Structure:** Process of Nucleation and Grain Growth, Ingot Solidification, Dendritic and Columnar Structure, Segregation of Impurities, Grain and Grain Boundaries.

**Unit III: Equilibrium Phase Diagrams and Phase Transformation :** Equilibrium of Phase Diagrams : Plotting of Equilibrium Diagrams, Interpretation, Phase Rule and Lever Rule and its Application Phase Transformations – Eutectic Eutectoid, Peritectic and Peritectoid.

**Practical Metallographic:** Preparation of Specimen, Selecting the Specimen, Mounting the Specimen, Grinding, Polishing, Etching and Etching Reagents. The Metallurgical Microscope. Use and Care of Microscope.

**Iron- Carbon Equilibrium System:** The Complete Iron Carbon Diagram and Its Interpretation. The Solidification and Cooling of Various Carbon Steels, Structures Produced, Correlation of Mechanical Properties with Carbon Content.

**Unit IV: Heat Treatment of Steels:** Objective of Heat Treatment, Thermal Processes- Annealing, Normalizing, Hardening and Tempering. Hardening Process : Surface Hardening, Flame Hardening, Case Hardening Methods, Their scope, Limitations and Advantages, Quenching Mediums and Their Effect on Hardness, T.T.T. Curves Interpretation and Use, Isothermal Heat Treatment Processes -Martempering, Austempering, Spheroidising and Patenting.

**Ferrous Metals and Alloys:** Classification, Types of Cast Irons their Properties and Uses, Alloy Cast-Irons, Various Alloying Elements Used, Their Effects on Properties and Uses. Classification, Composition and Uses of Plain Carbon Steels, Effect of Impurities, Alloy steels - Various Alloying Elements, Their Effects on Properties and Uses. Alloy Steel Classification. Tool Steel: Typical Compositions, Requirements of Tool Steels, High Speed Steel, High Carbon Steel. Standardization of Steels. Designation of Steels as per B.I.S. Codes.

**Unit V:Non- Ferrous Metals and Alloys:** Copper : Its Properties and Uses Copper Bases Alloys : Brasses, Their Classification, Composition, Properties and Uses, Designation of Copper Alloys as per B.I.S. Aluminium Its Properties and Uses. Aluminium Alloys: Their composition, Classification, Properties and Uses.

**Non- Metallic Materials:** Introduction to Ceramic Refractory, Rubbers Insulators and Lubricants Plastics: Characteristics, Classification, Commonly Used Thermo- Setting and Thermoplastic - Their Properties and Uses. Ingredients for Processing Plastics. Plastic Processing Methods Different Methods.

**OUTCOME:**

1. Explain the basic concepts of material science.
2. Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.
3. Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions.

**REFERENCES**

1. Engineering Physical Metallurgy-By Prof. Y Lakhtin MIR Publishers Moscow.
2. A Text Book of Material Science And Metallurgy by O.P. Khanna.
3. Material Science And Process. by S. K. Hazia Choudhry.
4. Mechanical Metallurgy by Dieter (Tata Mcgrawhill).
5. Materials Science by B.S. Narang ( Pub. CBS pub. & Distributions New Delhi).
6. Principles of Engineering Metallurgy, L. Krishna Reddy, New Age International Publishers.
7. Padarth Prodyogiki ( Hindi) by P.N. Vijayvergiya ( Deepak Prakashan, Gwalior) .