

## 4.1 MATERIALS AND METALLURGY

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### RATIONALE

Materials play an important role in the construction and manufacturing of equipment/tools. Right selection of materials add to the economy, working and life of machinery. A diploma holder must be conversant with the properties, uses, availability and costs of materials used for construction/fabrication to enable him to perform his functions confidently. The subject of Materials and Metallurgy has been designed to cover the above aspects.

### DETAILED CONTENTS

#### 1. Importance of Materials (4 hrs)

- Classification: Metals and non-metals, Ferrous and non-ferrous metals and their alloys
- Names of common metals, their alloys and non-metals used in Industry
- Properties of metals and alloys
- Physical properties - Appearance, luster, colour, density and melting point
- Mechanical Properties: Strength, stiffness, elasticity, plasticity, toughness, ductility, malleability, brittleness, hardness, fatigue and creep.
- Thermal and electrical conductivity
- Corrosion, causes, effects and prevention.

#### 2. Metallurgical Considerations (6 hrs)

Solidification of metals from liquid to solid state of pure metals, cooling curves of pure metals, dendritic solidification, crystal formation, types of crystal structure. Phase diagram of:

- (i) Solid-state solubility.
- (ii) Partial solubility.
- (iii) Nil solubility i.e. eutectic solution (Binary only). Effects of all alloying elements on engineering materials. Effect of grain size on mechanical properties.

### 3. Ferrous Metals and Alloys (12 hrs)

- Flow diagram for the production of ferrous metals from their ores, constituents of iron, iron carbon diagram.
- Classification, composition and uses of cast iron and plain carbon steels. IS, BS and SAE Grades
- Effect of alloying elements such as Aluminium, chromium, Nickel, Cobalt, Manganese, Molybdenum, tungsten, Vanadium, Silicon, Sulphur and Phosphorous on steels.
- Composition, properties, grades and uses of special steels such as High speed steel, Stainless steels, Silicon steels, Heat resistant steels, Spring steel.
- Heat Treatment: Iron-carbon diagram, objectives and practical aspects of heat treatment. Brief description and uses with examples of principal heat treatment processes, Annealing, Normalizing, Tempering, Hardening, Carburising, Nitriding and Cyaniding and applications. Examples in heat-treating engineering components time, temperature transformation curve.

### 4. Non-ferrous Metals and Alloys (12 hrs)

- Copper: Properties and uses
- Composition, properties and uses of copper alloys.
- Brasses: Cartridge brass, Nickel silver.
- Bronzes: Phosphor bronze, Al-bronze, Mn-bronze, and Gun metal.
- Properties and uses of Aluminium.
- Composition, properties and uses of Al-alloys e.g., Duralumin, Yellow metal, Magnalium and Hindalium
- Properties and uses of alloys of lead, tin and magnesium.
- Bearing Metals: Requisite qualities. Composition, properties and uses of white metal bearing, copper based bearing metals. Aluminium based bearing metals. Use of nylon/PTFE for bushes/bearings, bi-metallic and tri-metallic bushes

5. Identification and Examination of Metals and Alloys (1 hrs)
- Identification tests - Appearance, sound, filing, weight, magnetic, spark, bend and microstructure. Different types of etchants for preparation of surface structure.
6. Other Important Materials (10 hrs)
- Plastics: Definition, classification of plastics, fibre glass, reinforced plastics. Major applications of various plastics and their uses and grades.
  - Composite materials.
  - Heat insulating materials: Properties and uses of asbestos, glass wool, thermocole, cork, mica.
  - Electrical insulating materials. Properties and uses of china clay, leather, bakelite, ebonite, glass wool, rubber, felt.
  - Sound insulating materials: Cork, fibre boards.
  - Fabrication materials: Wood, plywood, rubber – natural and synthetic, Glass – plate glass, toughened glass, safety glass.
  - Refractory materials: General characteristics and uses of dolomite, ceramics.
  - Protective coating materials: Paints, primers, varnishes, enamels, putti, electroplating materials, rubasil, teflon coating.
  - Sealant and adhesives – Application and availability of sealant and adhesives for industrial user.
7. Selection, specifications and commercial availability of materials (3 hrs)
- Practical considerations for selection of material for different purposes
  - ISO/Bureau of Indian standard specifications for metals, non-metals, various components and materials.

**LIST OF PRACTICALS**

1. Classification of about 25 specimen of materials/parts in material lab, identify and indicate the type of materials with respect to their properties
2. Study of metallurgical microscope.
3. To prepare microscopic structure for examination and to examine the micro structure of specimens of various metals and alloys.
4. Study of heat treatment furnaces.
5. To study the effects of heat treatments processes on the following materials:
  - (i) Low carbon steel
  - (ii) Mild steel
  - (iii) High Carbon Steel

**RECOMMENDED BOOKS**

1. Material Science by GBS Narang, Khanna Publishers, New Delhi.
2. Material Science and Metallurgy by RB Choudary, Khanna Publishers, New Delhi.
3. Material Science by RK Rajput; SK Kataria and Sons, Delhi.
4. Materials and Matallurgy by D.S. Nutt. SK Kataria and Sons, Delhi.

## 4.2 HYDRAULIC AND PNEUMATIC SYSTEMS

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### RATIONALE

The diploma holders are supposed to have knowledge of hydraulic and pneumatic systems. Hence this subject has been introduced.

### DETAILED CONTENT

1. **Introduction** (6 hrs)  
Properties of liquid, intensity of pressure, pressure head, centre of pressure, total pressure on vertical and inclined flat surfaces. Gauge pressure and absolute pressure, atmospheric pressure, vacuum differential pressure with simple problems.
2. **Pressure Measurement** (6 hrs)  
Measurement of pressure by piezometer tube, manometer, inclined manometer, differential manometer, inverted differential manometer, simple problems, bourdon's pressure gauge. Pressure gauge calibration.
3. **Flow Measurement** (8 hrs)  
Types of flow, total energy, velocity head, pressure head, potential head, measurement of velocity, Bernoulli's theorem,  $C_c$ ,  $C_v$  and  $C_d$ . Practical applications of Bernoulli's theorem, simple problems.
4. **Flow Through Orifices** (4 hrs)  
Types of orifices, jet of water, vena contracta. Hydraulic coefficients, relation between  $C_c$ ,  $C_v$  and  $C_d$ . Time for emptying a tank.
5. **Pumps** (4 hrs)  
Study of Pumps. Reciprocating and Centrifugal.
6. **Flow Through Pipes** (6 hrs)  
Minor and Major losses, darcy's equation, chezy's equation (Without proof), simple problems.
7. **Hydraulic Circuits** (4 hrs)  
Study of construction of elements of hydraulic power pack such as

hydraulic pump, filter & reservoir, cooler, heater, oil level gauge & temperature gauge.

**8. Pneumatic Systems** (10 hrs)

Comparison of pneumatics with fluids, elements of pneumatic system, types of compressors- reciprocating, rotary. Selection of compressor. Air receivers. Industrial applications of pneumatics. Air filters, pressure regulator, and lubricators. Pneumatic valves- direction control valve, pilot operated valve. Pneumatic actuators. Pneumatic tools- rotary, piston type, hammer type.

**LIST OF PRACTICALS**

1. Study of piezometer tube, manometer and pressure gauge and its calibration.
2. To verify Bernoullie's Theorem.
3. To find coefficient of discharge for a venturimeter.
4. To determine coefficient of contraction, coefficient of velocity and coefficient of discharge for a given orifice.
5. Study of following equipment with a view to illustrate its constructional details, common problems and their remedies.
  - Centrifugal pumps
  - Single acting reciprocating pump
  - Hydraulic jack
6. Study of hydraulic circuit in general and its application on a surface grinder.
7. To study pneumatic circuit of any available machine or of Pneumatic brake of a vehicle.
8. To find the velocity of water flowing through pipe and also calculate the major head loss due to friction.

**RECOMMENDED BOOKS**

1. Hydraulics and hydraulic machines by Sarao and Khosla.
2. Hydraulics and Hydraulic machine by D.R. Malhotra.
3. Fluid Power and Tribology by Anil Agarwal and ML Bhatia, Scientific Publishers (India), Jodhpur – 342 001.
4. Hydraulics & Fluid Mechanics by Dr. Jagdish Lal; Metropolitan Book Co. Pvt., Ltd.
5. Hydraulics by R.S Khurmi.
6. Hydraulics: Fluid Mechanics and Fluid Machines by S. Ramamurthan; Dhanpat Rai & Sons, Delhi.

### 4.3 JIGS, FIXTURES AND GAUGES-DESIGN AND DRAWING

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#### RATIONALE

Knowledge regarding design & drawing of jigs, fixtures and gauges is essential as fixtures help to achieve mass production of components/parts at relatively low cost. The subject enables the students to know about the practices being adopted for design of jigs, fixtures & gauges.

#### DETAILED CONTENTS

##### Section A

1. **Jigs and Fixtures** (5 hrs)  
Concept of jigs & fixtures, need and advantages, concept of interchangeability, classification of jigs & fixtures.
2. **Location and Clamping devices** (7 hrs)  
Basic principles of location, 3-2-1 principle of location, location for various services, location methods and devices. Concept of clamping and various clamping devices.
3. **Drilling Jigs** (10 hrs)  
Definition of a drilling jig. Drilling jig. Drilling bushes & their function. Types of drilling jigs such as box type, channel jig, latch jig, indexing jig.
4. **Fixtures** (12 hrs)  
Introduction to fixtures, types of fixtures such as milling fixture (single piece, gang milling) lathe and boring fixtures, grinding and welding fixture. Application of pneumatic in jigs and fixtures.
5. **Limit gauges** (14 hrs)  
Introduction to plain limit gauges, classification of limit gauges such as plug, ring & snap gauges. Brief description of thread gauges. Material selection. Taylor's principle of maximum & minimum material condition. Go and not-go ends of gauges and selection of gauge for inspection.

**Section B**

6. Design and drawing of drilling jigs (at least 2 sheets) (10 hrs)
7. Design and drawing of fixtures for milling (at least 2 sheets) (10 hrs)
8. Design and drawing of limit gauges such as plug gauge, ring gauge and snap gauge (at least 1 each). (12 hrs)

**Note\*** The question paper on this subject will consist of two parts:  
Section A will contain theory part to the extent of 40%.  
Section B will contain design & drawing to the extent of 60%.

At least, 2 Industrial visits should be arranged in the related industry.

**RECOMMENDED BOOKS**

1. Prakash H Joshi, Press tools design & construction, Wheeler Publisher.
2. Donaldson, Fundamental of tool design.
3. Surrender Kr & Umesh Chandra, Production Engg. & Design, Satya Parkashan, New Delhi.
4. D. Engene Ostergard, Basic Die Making; Mc Graw Hill Book Co.
5. ASTME, "Fundamentals of Tool Design".
6. Handbook of Fixture Design, by Frank W. Wilson; Mc Graw Hill Book Company.



#### 4.4 WORKSHOP TECHNOLOGY-II

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##### RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about various machining processes, modern machining methods, processing of plastic, CNC machining, tool, jigs and fixtures is required to be imparted. Hence the subject of workshop technology.

##### DETAILED CONTENTS

1. Milling (15 hrs)
  - Specification and working principle of milling machine
  - Classification, brief description and applications of milling machines
  - Details of column and knee type milling machine
  - Milling machine accessories and attachment – Arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment, spiral milling attachment, slotting attachment and rack milling attachment.
  - Milling methods - up milling and down milling
  - Identification of different milling cutters and work mandrels
  - Work holding devices
  - Milling operations – face milling, angular milling, form milling, straddle milling and gang milling.
  - Cutting speed and feed, depth of cut.
  - Indexing on dividing heads, plain and universal dividing heads.
  - Indexing methods: direct, Plain or simple, compound differential and angular indexing.
  - Cutting fluids used in milling.
  
2. Grinding (10 hrs)
  - Purpose of grinding
  - Specifications of grinding wheel – Abrasive, Grade, structure, Bond
  - Common wheel shapes and types of wheel – built up wheels, mounted wheels and diamond wheels. Specification of grinding wheels as per BIS.
  - Truing, dressing, balancing and mounting of wheel.
  - Grinding methods – Surface grinding, cylindrical grinding and centreless grinding.
  - Grinding machine – Cylindrical grinder, surface grinder, internal grinder, centreless grinder, tool and cutter grinder.

- Selection of grinding wheel
  - Cutting fluids used in grinding.
3. Shaping, Planing and Slotting (8 hrs)
- Working principle of shaper, planer and slotter.
  - Quick return mechanism applied to shaper, slotter and planer machine.
  - Specification of shaper, planer and slotting machine.
  - Speeds, feeds and depth of cut.
4. Broaching (5 hrs)
- Introduction
  - Types of broaching machines – Single ram and duplex ram horizontal type, vertical type pull up, pull down, push down.
  - Elements of broach tool, broach teeth details – nomenclature, types, tool material.
5. Metal Forming Process (10 hrs)
- Press Working
    - a) Press working – Types of presses, type of dies, selection of press die, die material
    - b) Press Operations-Shearing, piercing, trimming, punching, notching, shaving, gearing, embossing, stamping
  - Forging
    - a) Open die forging, closed die forging
    - b) Cold and hot forging
  - Rolling
    - a) Elementary theory of rolling
    - b) Types of rolling mills
    - c) Rolling defects and remedies
  - Extrusion and Drawing
    - a) Type of extrusion- Hot and Cold, Direct and indirect
    - b) Pipe drawing, tube drawing

**RECOMMENDED BOOKS**

1. Workshop Technology by B.S. Raghuwanshi; Dhanpat Rai and Sons, Delhi.
2. Manufacturing Technology by M.Adithan and AB Gupta; New Age International (P) Ltd, Delhi.
3. Workshop Technology Vol. I, II, III by Chapman; Standard Publishers Distributors, New Delhi.
4. Practical Handbook for Mechanical Engineers by Dr. AB Gupta; Galgotia Publications, New Delhi.
5. Workshop Technology by R.C Jindal; Ishan Publications, Ambala city.
6. Production Engineering and Science by Pandey and Singh; Standard Publishers Distributors, New Delhi.
7. Workshop Practice by R.K. Singal, S K Kataria and Sons, New Delhi.
8. A text Book of Production Engineering by P.C. Sharma; S. Chand and Company Ltd., New Delhi.
9. Production Technology by HMT; Tata McGraw Publishers, New Delhi.

## 4.5 INSPECTION AND QUALITY CONTROL

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### RATIONALE

Diploma holders in this course required to measure and inspect for ensuring quality of product. For this purpose, knowledge and skills about standards of measurement, limits, fits and tolerances, types of inspection and various measuring instruments, SQC & quality standards are necessary. Hence this subject.

### DETAILED CONTENT

#### 1. Inspection (8 hrs)

- Introduction, units of measurement, standards for measurement and interchangeability.
- International, national and company standard, line and wavelength standards.
- Limits fits and tolerances: study of natural variability of process. Indian standards on limits, fits and tolerances including terminology, guide for selection of fits, clearance, transition and interference. Positional tolerances: maximum material condition usage of standards for deciding tolerance.
- Planning of inspection: what to inspect? When to inspect? Who should inspect? Where to inspect?
- Types of inspection: remedial, preventive and operative inspection, incoming, in-process and final inspection.
- Study of factors influencing the quality of manufacture.

#### 2. Measurement and Gauging (18 hrs)

- Basic principles used in measurement and gauging, mechanical, optical, electrical and electronic.
- Study of various measuring instruments like: calipers, micrometers, dial indicators, surface plate, straight edge, try square, protectors, sine bar, clinometer, comparators – mechanical, electrical and pneumatic. Slip gauges, tool room microscope, and profile projector, talysurf.  
Limit gauges: plug, ring, snap, taper, thread, height, depth, form, feeler, wire and their applications for linear, angular, surface, thread and gear measurements, gauge tolerances.
- Geometrical parameters & errors:  
Errors & their effect on quality, concept of errors, measurement of geometrical parameter such as straightness, flatness & parallelism.
- Study of procedure for alignment tests on lathes, drilling and milling machines.
- Testing and maintenance of measuring instruments.

3. **Statistical Quality Control** (12 hrs)

- Basic statistical concepts, empirical distribution and histograms, frequency, mean, mode, standard deviation, normal distribution, binomial and Poisson (No mathematical derivations).
- Introduction to control charts, namely X, R, P and C charts and their applications.
- Sampling plans, selection of sample size, method of taking samples, frequency of samples.
- Inspection plan format and test reports
- Concept of total quality management (TQM)

4. **Standards and Codes** (4 hrs)

- National and International Codes.
- ISO-9000, concept and its evolution and implications.

5. **Instrumentation** (6 hrs)

Measurement of mechanical quantities such as displacement, vibration, frequency, pressure temperature, humidity by electro mechanical transducers of resistance, capacitance & inductance type.

**LIST OF PRACTICALS**

1. Use of dial indicator for measuring taper.
2. Use of combination set, bevel protector and sine bar for measuring taper.
3. Measurement of thread characteristic using vernier and gauges.
4. Measurement of all elements of gauges by using flange micrometer, gear roller tester, gear tooth vernier and profile projector.
5. Use of slip gauge in measurement of center distance between two pins.
6. Use of tool maker's microscope and comparator.
7. Verify that when random samples are taken from a universe with a certain percentage of defectives same percentage tends to appear in random samples by using (Shewart's plastic kit box).
8. Plot frequency distribution for 50 turned components.
9. With the help of given data, plot X, R, P and C charts.

**LIST OF RECOMMENDED BOOKS**

1. Statistical Quality Control by M.Mahajan: Dhanpat Rai and Sons, Delhi
2. Engineering Metrology by RK Jain
3. Engineering Metrology by RK Rajput; SK Kataria and Sons
4. Production Planning Control and Management by KC Jain & Aggarwal; Khanna Publishers, New Delhi

## 4.6 WORKSHOP PRACTICE - II

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### RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, skills in various machining processes, modern machining methods, processing of plastic, CNC machining, tool, jigs and fixtures is required to be imparted. Hence the subject of workshop practice.

### LIST OF PRACTICALS

1. Produce a rectangular block by face milling and prepare a slot on one face with a slotting cutter / side and face cutter.
2. Gear manufacturing by some indexing device on a milling machine & gear hobber. Inspection of gear
3. Job on grinding using
  - Surface grinding
  - Cylindrical grinding
  - Centreless grinding
4. Milling cutter grinding on tool and cutter grinder.
5. Prepare a V-block to  $\pm 0.2$  mm accuracy on shaper machine.
6. Exercise on key way cutting and spline cutting.
7. Preparation of job through eccentric turning.
8. Practice of taper turning.
9. Exercise on EDM for preparation of electrodes(male and female).

**Note:** The workshop Superintendent will finalize the specific drawings of all the jobs in the beginning of semester in consultation with staff

## 4.7 CAD -I

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### RATIONALE

Computer aided drafting these days is extensively being used in the industry. This subject has been added to enable a diploma holder to make drawings using computer software and take prints/plots.

### PRACTICE WORK

Introduction to AutoCAD : Starting up, practice on – how to create a new drawing file, setting drawing limits & saving a file, drawing lines in different ways using absolute co-ordinates, user co-ordinates, WCS, UCS, drawing circles, drawing arcs, drawing ellipses. Drawing polygons, drawings splines. Drawing polylines, using window, zoom commands.

Practice on Edit commands such as erase, copy, mirror, array, offset, rotate, oops, undo, redo, scale, stretch, trim, break, extend, chamfer, fillet.

Practice on Text commands: editing text, text size, text styles, change properties commands.

Practice on Layer Commands: creating layer, freeze, layer on/off colour assigning, current layer, load line type, lock & unlock layer, move from one layer to other.

Practice on Hatching, Hatch pattern selection, practice on Dimensioning, linear dimensioning, angular dimensioning radius/.diameter dimensioning O-snap command, aligned dimensioning, editing of dimensioning, tolerances in dimensioning.

Practice on making complete drawings of components by doing exercises.

Practice on print/plot commands. Export/import commands

### RECOMMENDED BOOKS

1. AutoCAD by R.W. Leigh, Galgotia, Publication, New Delhi.
2. Engg. Drawing with AutoCAD 2000 by T. Jaypooran, Vikas Publishing House.

## INDUSTRIAL TRAINING

Industrial training aims at exposing the students to field practices, size and scale of operations and work culture at practical sites. For this purpose, students after fourth semester of the course are required to be sent for a period of 4 weeks to industry.

Each student is supposed to study the material and technology used at site and prepares a detailed report of the observation of processes seen by him/her. These students should be supervised and guided by respective subject teachers. Each teacher may guide a group of four to five students.

The teacher along with field supervisors will conduct performance assessment of students. The components of evaluation will include the following.

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|--------------------------------------|-----|
| a) Punctuality and regularity        | 15% |
| b) Initiative in learning new things | 15% |
| c) Relationship with workers         | 15% |
| d) Industrial training report        | 55% |