4.1 MATERIALS AND METALLURGY

L	T	P
3	-	2

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 form 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

L	T	P
3	-	2

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 Bernoullie's theorem, simple problems.

4. **Flow Through Orifices** (4 hrs)

   Types of orifices, jet of water, vena contracta. Hydraulic coefficients, relation between 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.
    a. Centrifugal pumps
    b. Single acting reciprocating pump
    c. 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 BASIC MECHANICAL ENGINEERING

L	T	P
3	1	2

RATIONALE

A diploma holder is supposed to select and analyze the reasons for failure of different components and select the required material for different applications. It is essential to teach the diploma holders about concepts, principles, applications and practices covering stresses and strain, beams, bending moment and shear force, springs and shafts. Knowledge in basic concepts of simple mechanism, flywheel and governor, balancing, vibrations and vehicle in motion is also very much required to understand the problems in the moving parts of automobile. It is expected that efforts will be made by the teachers to provide appropriate learning experiences to the students for developing necessary competencies related to this subject area.

DETAILED CONTENTS

SECTION - A

1. Stresses and strain (9 hrs)

- Introduction to stress and strain
- Mechanical properties of materials
- Tensile and compressive stress
- Shear stress and strain
- Hooke’s law and Young's Modulus of elasticity
- Modulus of Rigidity
- Poisson's ratio
- Bulk Modulus
- Deformation and stress in a uniform bar
- Deformation and stress in a non uniform bar
- Temperature stresses
- Longitudinal and hoop stress in thin and thick cylinders

2. Beams and Bending (8hrs)

- Concept of beam, rod, shaft (different types of structure members)
- Different types of supports - Fixed support, Roller support, Hinged support
- Concept of a simply supported beam and cantilever
- Concept of bending moments and shear force
- B.M. and S.F. diagrams for Beams - for uniformly distributed loads, for concentrated loads
- Determination of position of maximum B.M. and S.F. in a beam
- Point of contraflexure

3. Bending and Shear Stresses (7 hrs)

- Concept of Bending, bending equation and assumptions made in it
- Flexural formulae
- Concept of second moment of area for
  - Simple section
  - Rectangular cross section
  - Circular cross section
  - Triangular cross section
  - Hollow circular cross section
  - I-section
- Calculation of bending stresses for the above sections with given loading and span
- Section Modulus
- Average shear stress in Rectangular and I section

4. Springs (5 hrs)

- Strain energy and proof resilience. Castigliano's theorem
- Leaf Springs
- Maximum deflection in leaf springs
- Maximum stress in leaf springs
- Closed coiled and open coiled springs subjected to axial load and axial twist – maximum stress and deflection of free end
- Stiffness of a spring

5. Shafts (6 hrs)

- Concept of torque and angle of twist
- Torsion equation
- Torque developed by hollow and solid shafts of round sections
- Comparison of torque developed by hollow and solid shafts

SECTION - B

6. Simple Mechanism (4 hrs)

- Definition of link, kinematic pair, kinematic chain, mechanism, inversions and machines
- Simple examples of mechanism with lower pairs, four bar chain, slider crank chain, double slider crank chain and higher pairs

7. Flywheel and Governor (6 hrs)

- Flywheel concept of moment of inertia and radius of gyration
- Fluctuation of energy for flywheel
- Concept of a governor, comparison between a flywheel and a governor
- Types of governors and their working principle (without derivation)

8. Balancing (3 hrs)

- Concept of static and dynamic balancing

9. Vibrations (3 hrs)

- Causes of vibrations in machines, their harmful effects and remedies

LIST OF PRACTICALS

1. To study tensile behaviour of three different metals.

2. To calculate shear strength of two different metals under single and double shear.

3. Test on a spring to study comparative effects of gradual, sudden and falling loads.

4. Calculation of impact strength of metals by
   - Charpy test
   - Izod test

5. To calculate bending strength by performing bending test on
   - a steel box and wooden beam
   - a steel flat

6. To calculate torsion strength of 3 different metals by torsion test.

7. To calculate hardness of metals by
   - Rockwell hardness test
   - Vickers hardness test

8. Study of various types of mechanisms through models

9. Study of governors through models

10. Wheel balancing

RECOMMENDED BOOKS

1. Mechanics of Materials by Kirpal Singh, Standard Publishers/Distributors, New Delhi
2. Strength of Materials by R.S. Khurmi; S Chand and Company, Delhi
3. Elements of Strength of Materials by D.R. Malhotra and H.C. Gupta; Satya Parkashan, New Delhi
4. Theory of Machines by DR Malhotra and HC Gupta, Satya Prakashan, Delhi
5. Theory of Machines by PL Ballaney, Khanna Publishers, New Delhi

4.4 WORKSHOP TECHNOLOGY-II

L	T	P
3	-	-

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 MACHINE DESIGN AND DRAWING

L	T	P
3	-	3

RATIONALE

A diploma holder in this course is required to assist in the design and development of prototype and other equipments. For this, it is essential, that he is made conversant with the principles related to design of components and application of these principles for designing and prepare drawing of the same and hence this subject.

DETAILED CONTENT

1. **Introduction** (14 hrs)

- Design - Definition, types of designs necessity of design.
- Comparison of designed and undersigned work.
- Design procedure.
- Practical examples related with design procedure.
- Characteristics of a good designer.
- Characteristics of environment required for a designer.
- Design terminology: stress, strain, factor of safety, factors affecting factor of safety, stress concentration, methods to reduce stress concentration, fatigue, endurance limit.,
- General design considerations.
- Codes and standards.

2. **Design of keys and shafts.** (14 hrs)

Design of keys: Types of keys, materials of keys, and functions of keys. Design of keys.

Design of shafts: Types of shaft, type of loading on shafts, shaft materials, Effect of keyway on shaft strength, Design of shafts under various loading.

3. **Design of Joints** (14 hrs)

- Types of joints: Temporary and permanent, utility of joints.
- Permanent joints.
- Welded joints.
- Types of welded joints, strength of parallel and transverse fillet welds.
- Strength of combined parallel and transverse welds.
- Axially loaded welded joints.

- Riveted joints: rivet materials, rivet heads, leak proofing of riveted joints – caulking and fullering.
- Different modes of rivet joint failure.
- Design of riveted joints: lap, butt, diamond (Lozenzo).
- Design of boiler joints i.e. circumferential and longitudinal boiler joints.

4. **Design of Couplings** (14 hrs)

- Necessity of a coupling, advantages of a coupling and types of couplings, design of flanged couplings.

5. **Assembly Drawing of the following** (18 hrs)

- Tool post.
- Bench-vice.
- Safety valve.

6. **Cams** (12 hrs)

- Cam profile nomenclature.
- Types of followers.
- Motions of followers.
- To draw cams with different followers with different motions.

7. **Gears** (10 hrs)

- Types of gears.
- Nomenclature of gears.
- Conventional representation of gears.
- Draw profile of spar gear.

RECOMMENDED BOOKS

1. Machine Design by Pandya and Shah.
2. Machine Design by Sharma and Aggarwal; Katson Publishing House, Ludhiana.
3. Machine Design by R.S. Khurmi & J.K. Gupta; Eurasia Publishing House (Pvt.) Ltd.
4. Design of Machine elements by V.B. Bhandari; Tata Mc Graw Hill; Delhi.
5. Engineering Design by George Dieter; Tata Mc Graw Hill; Delhi.
6. Mechanical Engineering Design by Joseph Edwerd Shigley, Mc Graw Hill.
7. Machine Design by Sadhu Singh.
8. Machine Design by G.R. Nagpal.
9. Machine Design Data Book.

4.6 WORKSHOP PRACTICE - II

L	T	P
-	-	9

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 INSPECTION AND QUALITY CONTROL

L	T	P
3	-	2

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 insect? 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

INDUSTRIAL TRAINING

Industrial Training aims at exposing the students to field practices, size and scale of operation and work culture at practical sites. For this purpose, students at the end of fourth semester, are required to be sent for a period of 4 weeks in industry**.**

As a minor project activity, each student is supposed to study the material and technology used at site and prepares a detailed project report of the observation of process 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.

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