

### 3.1 MATERIAL SCIENCE

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#### RATIONALE

Lot of development has taken place in the field of materials. New materials are being developed and it has become possible to change the properties of materials to suit the requirements. Diploma holders in this course are required to make use of different materials for various applications. For this purpose, it is necessary to teach them basics of metal structure, properties, usage and testing of various ferrous and non-ferrous materials and various heat treatment processes. This subject aims at developing knowledge about the characteristics, testing and usage of various types of materials used in Mechanical Engineering industry.

**NOTE: Weightage of each topic for external examination is given in brackets**

#### DETAILED CONTENTS

1. **General** (10%)
  - 1.1 Introduction to engineering materials
  - 1.2 Classification of materials
  - 1.3 Thermal, Chemical, electrical, mechanical properties of various materials.
  - 1.4 Selection criteria for use in industry
2. **Structure of Metals and their Deformation** (15%)
  - 2.1 Metal Structure – Relation of metal structure to its properties
  - 2.2 Arrangement of atoms in metals (Basic idea)
  - 2.3 Crystalline structure of metals
  - 2.4 Crystal Imperfections
  - 2.5 Deformation of metal
  - 2.6 Impact of cold and hot working on metal structure
  - 2.7 Corrosion, its cause and prevention
3. **Ferrous Materials** (20%)
  - 3.1 Classification of iron and steel
  - 3.2 Sources of iron ore and its availability
  - 3.3 Manufacture of pig iron, wrought iron, Cast iron and steel (Flow Diagrams only)
  - 3.4 Types of Cast Iron: White, malleable, grey, mottled, modular and alloy and their usage
  - 3.5 Concept of Powder Metallurgy.
  - 3.6 Steels and alloy steel
    - i) Classification of steels
    - ii) Different manufacturing methods of steel – open hearth, Bessemer, electric arc.

- iii) Availability, Properties and usage of steels
- iv) Specification as per BIS and equivalent standards.
- v) Effect of various alloying element like Cr, Ni, Co, V, W, Mo, Si, Mn, S on mechanical properties of steel.
- vi) Use of alloy steels (high speed steel, stainless steel, spring steel, silicon steel)

4. **Non Ferrous Materials** (15%)

- 4.1 Important ores and properties of Aluminium, Copper, Zinc, Tin, Lead
- 4.2 Properties and uses of Al alloys, Copper alloys, Bearing metals, solders

5. **Engineering Plastics and Fibers** (10%)

- 5.1 Important sources of plastics
- 5.2 Classification – thermo and thermo set plastic.
- 5.3 Various Trade names of engineering plastics
- 5.4 Plastic Coating
- 5.5 Fibers and their classification: Inorganic and Organic Fibers
- 5.6 Usage of fibers

6. **Insulating Materials** (10%)

- 6.1 Various heat insulating material and their usage like asbestos, glass wool, thermocole, cork, puf, china clay.
- 6.2 Various electrical insulating material and their use like China clay, leather, bakelite, Ebonite, glass wool, rubber, felt
- 6.3 Ceramics-Classification, properties, applications

7. **Testing of Metals and Alloys** (5%)

Identification test: appearance, sound, spark, weight, magnetic, band microstructure, filing.

8. **Fundamentals of Heat Treatment** (15%)

- 8.1 Purpose of heat treatment
- 8.2 Theory of solid solution
- 8.3 Iron-Carbon Diagram
- 8.4 TTT Curve in steels and its importance
- 8.5 Basic idea about martensitic transformation
- 8.6 Various heat treatment processes-hardening, tempering, annealing, normalizing, case hardening (elementary idea)
- 8.7 Types of heat treatment furnaces
- 8.8 Concepts of Vacuum Heat Treatment

**LIST OF PRACTICAL (MATERIAL SCIENCE)**

Classification of about 25 specimens of materials/parts into

- i) Metals and non metals
- ii) Metals and alloys

- iii) Ferrous and non ferrous metals
  - iv) Ferrous and non ferrous alloys
  - 2. Given a set of specimen of metals and alloys (copper, brass, aluminium, cast iron, HSS, Gun metal); identify and indicate the various properties possessed by them
  - 3.
    - i) Study of heat treatment furnace
    - ii) Study of a thermocouple/pyrometer
  - 4. Study of a metallurgical microscope and a diamond-polishing machine
  - 5. To prepare specimens of following materials for microscopic examination and to examine the microstructure of the specimens of following materials:
    - i) Brass
    - ii) Copper
    - iii) Grey CI
    - iv) Malleable CI
    - v) Low carbon steel
    - vi) High carbon steel
    - vii) HSS
  - 6. To anneal a given specimen and find out difference in hardness as a result of annealing
  - 7. To normalize a given specimen and to find out the difference in hardness as a result of normalizing
  - 8. To temper a specimen and to find out the difference in hardness and tensile strength due to tempering
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### 3.2 THERMAL ENGINEERING-I

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#### RATIONALE

A diploma holder in mechanical engineering is supposed to maintain steam generators, turbines and other power plant equipment. In addition he is required to maintain various types of automobiles. Therefore, it is essential to teach him concepts, principles and applications of basic thermodynamics. steam generators, steam turbine and other power plant equipment: non-conventional energy sources and about IC engines. Hence this subject.

NOTE: - Weightage of each topic for external examination is given in the brackets

#### DETAILED CONTENTS

1. **Basic Concepts and Gas laws** (10%)
  - i) Gas laws : Boyle's Law, Charle's Law
  - ii) Characteristics equation, Gas constant, Universal Gas constant.
  - iii) Thermodynamics, system (open and closed), surroundings, property, process, cycle quasi-static process. Heat, specific heat, thermodynamic concept of work. 6
  - iv) Constant Volume, constant pressure Isothermal, adiabatic and polytropic processes, Throttling and free Expansion, work done under these processes.
2. **Laws of Thermodynamics** (15%)
  - i) Explanation of the Zeroth law of Thermodynamics
  - ii) First law of thermodynamics for a closed system undergoing a cycle; for a process.
  - iii) Concept of Internal energy. - *Point function*. 6
  - iv) First Law of Thermodynamics for an open system - steady flow energy equation.
  - v) Clausius and Kelvin Planck statements of second law of thermodynamics.
  - vi) Concept of Entropy.
  - vii) Entropy change during various processes.
3. **Formation of Steam and its Properties** (20%)
  - i) Steam formation at constant pressure
  - ii) Wet steam, dry steam and saturated steam.
  - iii) Dryness fraction
  - iv) Sensible heat, latent heat, total heat, internal energy, specific volume.
  - v) Expansion of vapors according to various thermodynamic processes.
  - vi) Use of steam table
  - vii) Entropy of water, wet, dry and superheated steam
  - viii) Use of temperature Entropy charts.

4. **Steam Generator** (15%)
- Uses of steam
  - Classification of boilers.
  - Comparison of fire tube and water tube boilers
  - Constructional features of Lancashire, Cochran, Babcock and Wilcox boilers.
  - Boiler mountings
  - Boiler accessories – economizer, super heater.
  - Introduction to fuel for boilers.
  - Performance of boilers – equivalent evaporation, Boiler efficiency.
5. **Steam Prime Movers** (10%)
- Rankine cycle, modified Rankine cycle, efficiency Rankine cycle, Indicator diagram. Effect of pressure and temperature on Rankine cycle, Reheat cycle, Regenerative cycle.
  - Flow through nozzles, calculation of exit velocities and conditions for maximum discharge.
  - Principles, construction and working of Impulse and Reaction Turbines. Pressure and velocity compounding its advantages and disadvantages. Bleeding of steam and its effect on steam turbine efficiency, limits on number of bleeding (No numerical)
6. **Steam Condensers** (10%)
- Function, working principle, classification and description of surface condensers.
  - Cooling Towers and cooling ponds.
  - Sources of air in condensers.
  - Simple calculations for cooling water in condensers.
7. **Steam Power Plant** (5 %)
- General description with a layout diagram showing details of all units.
8. **Heat Transfer** (15%)
- Thermal conduction, basic equation, conduction through a thick plain wall, composite wall and pipe lagging.
  - Thermal convection, natural and forced convection, basic equation.
  - Thermal radiation, reflection absorption, and transmission. Concept of black, white and opaque bodies, Stefan Boltzman's Law (simple problems on Heat Transfer)

### LIST OF PRACTICALS (THERMAL ENGINEERING-I)

- Study of pressure gauge and water level indicator on a boiler.
- Study of stop valve, dead weight safety valve and fusible plug.
- Study of stop lever and spring loaded safety valve, high steam and low water alarm.

4. Study of blow off cock, feed check valve and feed - water pump.
5. Study of Lancashire Boiler.
6. Study of Cochran Boiler
7. Study of Babcock and Wilcox Boiler
8. Study of super heating and throttling calorimeter.
  - i) Study of economizer and super heater
  - ii) Study of impulse and reaction turbines through models.
  - iii) Visit to a thermal power plant

Note:

- \* - An expert may be invited from the industry to deliver the lecture
  - \*\* - An industrial visit may be planned to explain and show
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### RATIONALE

The objective of this subject is to impart fundamental knowledge and skills regarding basic electrical and electronics engineering, which diploma holders will come across in their professional life. This course will provide the students to understand the basic concepts and principles of D.C. and A.C. fundamentals, electromagnetic induction, transformers, motors distribution system, domestic installation, electrical safety etc. The students will also learn basic electronics including diodes and transistors and their applications.

**NOTE:** Weightage of each topic for external examination is given in the brackets

### DETAILED CONTENTS

1. **Basic Quantities of Electricity** (8%)  
Definition of voltage, current, power and energy with their units, name of instruments used for measuring above quantities. Connection of the instruments in an electric circuit
2. **Application and Advantages of Electricity** (5%)  
Difference between AC and DC, various applications of electricity, advantages of electrical energy over other types of energy
3. **Electromagnetic Induction** (7%)  
Definition, construction & principle of working of Transformer. Production of e.m.f., idea of transformer and it's numerical.
4. **Various Types of Power Plants** (10%)  
Elementary block diagrams of thermal, hydro and nuclear power stations. Brief explanation of the principle of power generation in above power stations
5. **Elements of Transmission Line** (10%)  
Pictorial diagram of 3-phase transmission and distribution system showing transformers, supports, conductors, insulators and earth wire etc. Brief function of accessories of transmission lines
6. **Distribution system** (15%)  
Distinction between high and low voltage distribution system, Identification of 3-phase wire, neutral wires and earth wire on a voltage distribution system. Identification of voltages between phases and between one phase and neutral. Distinction between 3-phase and 1-phase supply.
7. **Supply from Poles to Distribution System** (10%)  
Arrangement of supply system from pole to the distribution board. Function of service line, energy meter, main switch, distribution board

8. **Domestic Installation**

Distinction between light and fan circuits and 1-phase power circuit, sub-circuits. Various accessories and parts of Installation. Identification of wiring systems. Common safety measures on earthing. (15%)

9. **Electric Motor**

Definition and various applications of single phase and 3-phase motors. Connection and starting of 3-phase motors by star-Delta starter. Conversion of HP units watts and KW. (6%)

10. **Electrical Safety**

Electrical shock and precautions against shock, treatment of electric shock, concept of fuses and their classification, selection and application, concept of earthing and various types of earthing, applications of MCBs and ELCBs (7%)

11. **Basic Electronics**

Basic idea of semiconductors – P and N type; diodes, zener diodes and their applications, transistor – PNP and NPN, symbols, identification of terminals of transistor, current flowing in a transistor, its characteristics and uses. Characteristics and applications of a thyristor. Basic idea of MOSFET & IGBT. Concept of PLC & Sensors. (7%)

**LIST OF PRACTICALS:-**

1. Study of shock treatment & its precautions.
  2. Use of Megger
  3. Charging of Battery
  4. Transformer-to measure input and output voltage and currents of a loaded transformer
  5. Trouble shooting in domestic wiring system
  6. Connection of a one-phase induction motor to supply and reversing of its direction of rotation
  7. Connection of and reading of an electric energy meter
  8. Study of a distribution Board for domestic installation
  9. Draw V-I characteristics of P-N junction diode
  10. Draw input and output characters of a transistor
  11. Draw reverse break down characteristics of a zener diode
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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 manufacturing processes is required to be imparted. Hence the subject of workshop technology.

**DETAILED CONTENTS**

1. **Cutting Tools and Cutting Materials** (10%)
  - 1.1 Cutting Tools - Various types of single point cutting tools and their uses, Single point cutting tool geometry, tool signature and its effect, Heat produced during cutting and its effect, Cutting speed, feed and depth of cut and their effect
  - 1.2 Cutting Tool Materials - Properties of cutting tool material, Study of various cutting tool materials viz. High-speed steel, tungsten carbide, cobalt steel cemented carbides, stellite, ceramics and diamond.
2. **Lathe** (20%)
  - 2.1 Working principle of turning
  - 2.2 Function of various parts and accessories of a lathe
  - 2.3 Classification and specification of various types of lathe
  - 2.4 Work holding devices
  - 2.5 Lathe tools and operations :- Plain and step turning, facing, parting off, taper turning, eccentric turning, drilling, reaming, boring, threading and knurling, form turning, spinning.
  - 2.6 Cutting parameters - Speed, feed and depth of cut for various materials and for various operations, machining time.
  - 2.7 Speed ratio, preferred numbers of speed selection.
  - 2.8 Introduction to capstan and turret lathe
3. **Welding** (20%)
  - 3.1 Welding Process  
Principle of welding, Classification of welding processes, Advantages and limitations of welding, Industrial applications of welding, Welding positions and techniques, symbols.
  - 3.2 Gas Welding  
Principle of operation, Types of gas welding flames and their applications, Gas welding equipment - Gas welding torch, Oxy acetylene cutting torch, Blow pipe, Pressure regulators, Filler rods and fluxes
  - 3.3 Arc Welding  
Principle of operation, Arc welding machines and equipment, A.C. and D.C. arc welding, Effect of polarity, current regulation and voltage regulation

3.4 Other Welding Processes

- Resistance welding, introduction to spot, seam and projection welding
- Modern welding methods – TIG, MIG, ultrasonic welding, laser welding, robotic welding

3.5 Welding Defects

Types of welding defects, methods of controlling welding defects, inspection of welding defects

4. **Pattern Making**

(10%)

Types of pattern, Pattern material, Pattern allowances, Pattern codes as per B.I.S., Introduction to cores, core boxes and core materials, Core making procedure, Core prints, positioning of cores

5. **Moulding and Casting**

(25%)

5.1 Moulding Sand

Properties of moulding sand, their impact and control of properties. Various types of moulding sand.

5.2 Mould Making

Types of moulds, molding boxes, hand tools used for mould making, molding processes, molding machines: squeeze machine, jolt squeeze machine and sand slinger.

5.3 Casting Processes

Charging a furnace, melting and pouring both ferrous and non ferrous metals, cleaning of castings, Principle, working and applications of Die casting, investment Casting

5.4 Gating and Riser System

Elements of gating system, Pouring basin, sprue, runner, gates, Types of risers, location of risers, Directional solidification

5.5 Melting Furnaces

Construction and working of Pit furnace, Cupola furnace, Crucible furnace – tilting type, Electric furnace

5.6 Casting Defects

Different types of casting defects, Testing of defects through magnetic particle inspection.

6. **Metal Forming Processes**

(15%)

6.1 Press Working - Types of presses, type of dies, selection of press die, die material. Press Operations-Shearing, piercing, trimming, punching, notching, shaving, gearing, embossing, stamping

6.2 Forging - Open die forging, closed die forging, Press forging, upset forging, swaging, up setters, roll forging, Cold and hot forging

6.3 Rolling - Elementary theory of rolling, Types of rolling mills, Thread rolling, roll passes, Rolling defects and remedies

6.4 Extrusion and Drawing - Type of extrusion- Hot and Cold, Direct and indirect. Pipe drawing, tube drawing, wire drawing

### 3.5 MACHINE DRAWING-I

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#### RATIONALE

Diploma holders in mechanical engineering are required to read and interpret drawing and therefore, it is essential that they have skills of preparing drawing and sketches of various components, tools, jigs and fixtures. For this purpose, knowledge and skills for preparing drawings of couplings, bearings, bracket, pulleys, pipe joint, and lathe parts, boiler parts and I.C. Engine parts and jigs and fixtures are required to be imparted for enabling them to work in the field of mechanical engineering – be it manufacturing, testing of other function areas. This subject aims at development of drawing competencies in the students. While preparing drawings, stress should be laid on layout, cleanliness, conceptualization, dimensions and specifications.

#### DETAILED CONTENTS

1. Lecture on Limits, Fits, Tolerances and surface finish (15%)
2. Lecture on Bushed Bearings.  
Sheet # 1, 2 & 3 Simple Bush bearing, Ball Bearing, Plummer Block, Foot Step Bearing\* (25%)
3. Lecture on Universal Coupling, Wall Bracket.  
Sheet# 4 & 5 on Universal Coupling\*, Wall Bracket. (15%)
4. Lecture on Lathe Parts.  
Sheet 6 & 7 on Tool Post\*, Tail Stock\* (15%)
5. Lecture on Bench Vice and Screw Jack.  
Sheet # 8 & 9 Bench Vice\*, Screw Jack\* (15%)
6. Lecture on I. C. Engine Parts.  
Sheet # 10 Piston\*. Connecting Rod, Crank Shaft in the sketchbook. (15%)
7. Reading and interpreting of Drawing

\* means at least 4 drawings should be made from the actual parts made available to the student and the student should sketch the views in the sketchbook along with dimensions. The final scaled drawing is to be made from the data recorded in the sketchbook. Four turns are allotted for this.

**Third Angle Projection to be followed.**



### 3.6 ENVIRONMENTAL STUDIES

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Unit 1: **The Multidisciplinary nature of environmental studies**  
Definition, scope and importance, Need for public awareness. (5%)

Unit 2: **Natural Resources**  
**Renewable and non renewable resources:** (15%)

a) Natural resources and associated problems

- Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people.
- Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.
- Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, case studies.
- Energy Resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies
- Land Resources: Land as a resource, land degradation, man induces land slides, soil erosion, and desertification.

b) Role of individual in conservation of natural resources.

c) Equitable use of resources for sustainable life styles.

Unit 3: **Eco Systems** (15%)

- Concept of an eco system
- Structure and function of an eco system.
- Producers, consumers, decomposers.
- Energy flow in the eco systems.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following eco systems:
- Forest ecosystem
- Grass land ecosystem
- Desert ecosystem.
- Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4: **Biodiversity and it's Conservation** (15%)

- Introduction-Definition: genetics, species and ecosystem diversity.

- Biogeographically classification of India.
- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, national and local level.
- India as a mega diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts.
- Endangered and endemic species of India.
- Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

#### Unit 5: **Environmental Pollution**

(15%)

Definition Causes, effects and control measures of:

- a) Air pollution
- b) Water pollution
- c) Soil pollution
- d) Marine pollution
- e) Noise pollution
- f) Thermal pollution
- g) Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban and industrial wastes

Role of an individual in prevention of pollution Pollution case studies Disaster management: Floods, earth quake, cyclone and land slides

#### Unit 6: **Social issues and the Environment**

(15%)

- Form unsustainable to sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, water shed management
- Resettlement and rehabilitation of people; its problems and concerns, case studies
- Environmental ethics: issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environment protection Act
- Air (prevention and control of pollution) Act
- Water (prevention and control of pollution) Act
- Wildlife protection act
- Forest conservation act
- Issues involved in enforcement of environmental legislations

- Public awareness

**Unit 7: Human population and the environment**

**(10%)**

- Population growth and variation among nations
- Population explosion- family welfare program
- Environment and human health
- Human rights
- Value education
- HIV / AIDS
- Women and child welfare
- Role of information technology in environment and human health
- Case studies

**Unit 8: Field work**

**(10%)**

Visit to a local area to document environment assets river / forest / grassland / hill/ mountain. Visit to a local polluted site-urban/rural/industrial/agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc (field work equal to 5 lecture works)



### 3.6 WORKSHOP PRACTICE - III

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#### LIST OF PRACTICALS

General introduction to tools, equipments & machinery used in welding, pattern making, foundry, fitting and turning shop along with safety precautions.

##### Welding Shop

- Job 1. Preparing gas welding joint in vertical position joining M.S. Plates
- Job 2. Exercise on gas cutting of mild steel plate with oxy-acetylene gas torch.
- Job 3. Exercise on preparation of T Joint by arc welding.
- Job 4. A visit to a welding shop for detailed demonstration on MIG and TIG welding.

##### Pattern making

- Job 1. Preparation of solid/single piece pattern.
- Job 2. Preparation of two piece/split pattern
- Job 3. Preparation of a pattern on wooden lathe
- Job 4. Preparation of a self cored pattern and core box

##### Foundry Shop

- Job 1. Preparation of mould with solid pattern on floor.
- Job 2. Preparation of floor mould of split pattern in cope and drag of moulding box.
- Job 3. Moulding and casting of a solid pattern of aluminum.
- Job 4. A visit to foundry shop to have first hand knowledge of melting, pouring and casting.

##### Fitting Shop

- Job 1&2. Exercise involving Male & Female parts.
- Job 3. Preparation of simple die

##### Turning Shop

- Job 1. Exercise on preparation of single point cutting tool.
- Job 2. Exercise involving facing & plain turning.
- Job 3. Exercise involving step turning.