

### 3.1 STRENGTH OF MATERIALS

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4 - 2

#### RATIONALE

Diploma holders in this course are required to analyze reasons for failure of different components and select the required material for different applications. For this purpose, it is essential to teach them concepts, principles, applications and practices covering stress, strain, bending moment, shearing force, shafts, columns and springs. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles in the solution of applied problems to develop the required competencies.

#### DETAILED CONTENTS

1. Stresses and Strains (08 hrs)
  - 1.1. Concept of load, stresses and strain
  - 1.2. Tensile compressive and shear stresses and strains
  - 1.3. Concept of Elasticity, Elastic limit and limit of proportionality.
    - 1.3.1. Hook's Law
    - 1.3.2. Young Modulus of elasticity
    - 1.3.3. Nominal stress
    - 1.3.4. Stress strain diagram
    - 1.3.5. Yield point, plastic stage
    - 1.3.6. Ultimate strength and breaking stress
    - 1.3.7. Percentage elongation
    - 1.3.8. Proof stress and working stress
    - 1.3.9. Factor of safety
    - 1.3.10. Poisson's ratio
    - 1.3.11. Shear modulus
  - 1.4. Longitudinal and circumferential stresses in seamless thin walled cylindrical shells (derivation of these formulae not required)
2. Resilience (06 hrs)
  - 2.1 Resilience, proof resilience and modulus of resilience
  - 2.2 Strain energy due to direct stresses
  - 2.3 Stresses due to gradual, sudden and falling load.
  - 2.4 Numerical problems
- 3 Moment of Inertia (06 hrs)
  - 3.1. Concept of moment of Inertia and second moment of area

- 3.2. Radius of gyration , section modulus
- 3.3. Theorem of perpendicular axis and parallel axis ( without derivation)
- 3.4. Second moment of area of common geometrical sections: Rectangle, Triangle, Circle (without derivation) Second moment of area for I,T, L, Z section
- 3.5 Simple numerical problems.
  
4. Bending Moment and Shearing Force (10 hrs)
  - 4.1 Concept of beam and type of loading
  - 4.2 Concept of end supports-Roller, hinged and fixed
  - 4.3 Concept of bending moment and shearing force
  - 4.4 B.M. and S.F. Diagram for cantilever and simply supported beams with and without overhang subjected to concentrated and U.D.L.
  - 4.5 Simple numerical problems
  
5. Bending stresses (08 hrs)
  - 5.1 Concept of Bending stresses
  - 5.2. Theory of simple bending
  - 5.3. Use of the equation  $f/y = M/I = E/R$
  - 5.4. Concept of moment of resistance
  - 5.5. Bending stress diagram
  - 5.6. Calculation of maximum bending stress in beams of rectangular, circular, and T section.
  - 5.7 Permissible bending stress Section modulus for rectangular, circular and symmetrical I section.
  - 5.8 Simple numerical problems
  
- 6 Columns (08 hrs)
  - 6.1. Concept of column, modes of failure
  - 6.2. Types of columns
  - 6.3. Buckling load, crushing load
  - 6.4. Slenderness ratio
  - 6.5. Factors effecting strength of a column
  - 6.6 End restraints
  - 6.7 Effective length
  - 6.8 Strength of column by Euler Formula without derivation
  - 6.9. Rankine Gourdan formula ( without derivation)
  - 6.10 Simple numerical problems
  
- 7 Torsion (08hrs)
  - 7.1 Concept of torsion- difference between torque and torsion.
  - 7.2 Use of torque equation for circular shaft
  - 7.3 Comparison between solid and hollow shaft with regard to their strength and weight.

- 7.4 Power transmitted by shaft
- 7.5 Concept of mean and maximum torque
- 7.6 Simple numerical problems
  
- 8. Springs (10 hrs)
  - 8.1. Closed coil helical springs subjected to axial load and impact load
  - 8.2 Stress deformation
  - 8.3 Stiffness and angle of twist and strain energy
  - 8.4 Proof resilience
  - 8.5 Laminated spring (semi elliptical type only)
  - 8.6 Determination of number of plates
  - 8.7 Simple numerical problems

### **LIST OF PRACTICALS**

1. Tensile test on bars of Mild steel and Aluminium.
2. Bending tests on a steel bar or a wooden beam.
3. Impact test on metals
  - a) Izod test
  - b) Charpy test
4. Torsion test on specimens of different metals for determining modulus of rigidity.
5. To determine the stiffness of a helical spring and to plot a graph between load and extension.
6. Hardness test on different metals.

### **INSTRUCTIONAL STRATEGY**

1. Expose the students to real life problems.
2. Plan assignments so as to promote problem solving abilities and develop continued learning skills.

### **RECOMMENDED BOOKS**

1. SOM by Birinder Singh,; Katson Publishing House, New Delhi.
2. SOM by RS Khurmi; S.Chand & Co; New Delhi
3. Elements of SOM by D.R. Malhotra & H.C.Gupta; Satya Prakashan, New Delhi.

**SUGGESTED DISTRIBUTION OF MARKS**

<b>Topic No.</b>	<b>Time Allotted (Hrs)</b>	<b>Marks Allotted (%)</b>
1	08	12
2	06	10
3	06	10
3	10	16
4	08	12
5	08	12
6	08	12
7	10	16
<b>Total</b>	<b>64</b>	<b>100</b>

## 3.2 THERMODYNAMICS

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4 - 2

### RATIOANLE

A diploma holder in this course is supposed to maintain steam generators, turbines, compressors and other power plant equipment. Therefore, it is essential to impart him basic concepts of thermodynamics, steam generators, steam turbines, compressors and about IC engines.

### DETAILED CONTENTS

1. Fundamental Concepts (07 hrs)

Thermodynamic state and system, boundary, surrounding, universe, thermodynamic systems – closed, open, isolated, adiabatic, homogeneous and heterogeneous, macroscopic and microscopic, properties of system – intensive and extensive, thermodynamic equilibrium, quasi – static process, reversible and irreversible processes, Zeroth law of thermodynamics, definition of properties like pressure, volume, temperature, enthalpy, internal energy.

2. Laws of Perfect Gases (06 hrs)

Definition of gases, explanation of perfect gas laws – Boyle’s law, Charle’s law, Avagadro’s law, Regnault’s law, Universal gas constant, Characteristic gas constants, derivation

Specific heat at constant pressure, specific heat at constant volume of gas, derivation of an expression for specific heats with characteristics, simple problems on gas equation

3. Thermodynamic Processes on Gases (08 hrs)

Types of thermodynamic processes – isochoric, isobaric, isothermal, hyperbolic, isentropic, polytropic and throttling processes, equations representing the processes

Derivation of work done, change in internal energy, change in entropy, rate of heat transfer for the above processes

4. Laws of Thermodynamics (12 hrs)

Laws of conservation of energy, first law of thermodynamics (Joule’s experiment), Application of first law of thermodynamics to non-flow systems – Constant volume, constant pressure, Adiabatic and polytropic processes, steady flow energy equation, Application of steady flow energy to equation, turbines, pump, boilers, compressors, nozzles, evaporators, limitations.

Heat source and heat sinks, statement of second laws of thermodynamics: Kelvin Planck's statement, Clausius statement, equivalence of statements, Perpetual motion Machine of first kind, second kind, Carnot engine, Introduction of third law of thermodynamics, concept of irreversibility, entropy.

5. Ideal and Real Gases (06 hrs)

Concept of ideal gas, enthalpy and specific heat capacities of an ideal gas, P – V – T surface of an ideal gas, triple point, real gases, Vander-Wall's equation

6. Properties of Steam (07 hrs)

Formation of steam and related terms, thermodynamics properties of steam, steam tables, internal latent heat, internal energy of steam, entropy of water, entropy of steam, T- S diagrams, Mollier diagram (H – S Chart), Expansion of steam, Hyperbolic, reversible adiabatic and throttling processes

Quality of steam (dryness fraction), finding dryness fraction using separating and throttling calorimeter, Rankine cycle

7. Steam Generators (06 hrs)

Uses of steam, classification of boilers, comparison of fire tube and water tube boilers. Construction features of Lancashire boiler, nestler boiler, Babcock & Wilcox Boiler. Introduction to modern boilers.

8. Air Compressors (08 hrs)

Functions of air compressor – uses of compressed air, type of air compressors

Single stage reciprocating air compressor, its construction and working, representation of processes involved on P – V diagram, calculation of work done.

Multistage compressors – advantages over single stage compressors, use of air cooler – condition of minimum work in two stage compressor (without proof), simple problems

Rotary compressors – types, descriptive treatment of centrifugal compressor, axial flow compressor, vane type compressor

9. Introduction to Heat Transfer (04 hrs)

Modes of heat transfer, Fourier's law, steady state conduction, composite structures, Natural and forced convection, thermal radiation

## LIST OF PRACTICALS

1. Determination of temperature by
  - 1.1 Thermocouple
  - 1.2 Pyrometer
  - 1.3 Infrared thermometer
2. Demonstration of mountings and accessories on a boiler.
3. Study of boilers ( through industrial visit)
4. Study of air compressors.
5. Demonstration of heat transfer through conduction, convection and Radiation

## INSTRUCTIONAL STRATEGY

1. Expose the students to real life problems.
2. Plan assignment so as to promote problem solving abilities.

## RECOMMENDED BOOKS

1. Engineering Thermodynamics by PK Nag; Tata McGraw Hill, Delhi.
2. Basic Engineering Thermodynamics by Roy Chaudhary; Tata McGraw Hill, Delhi.
3. Engineering Thermodynamics by CP Arora; Tata McGraw Hill, Delhi.
4. A Treatise on Heat Engineering by VP Vasandani and DS Kumar; Metropolitan Book Company.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	07	12
2	06	10
3	08	12
4	12	18
5	06	10
6	07	10
7	06	10
8	08	12
9	04	06
<b>Total</b>	<b>64</b>	<b>100</b>

### 3.3 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

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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.

#### DETAILED CONTENTS

1. Application and Advantage of Electricity (04 hrs)  
Difference between ac and dc, various applications of electricity, advantages of electrical energy over other types of energy
2. Basic Electrical Quantities (04 hrs)  
Definition of voltage, current, power and energy with their units, name of instruments used for measuring above quantities
3. Electromagnetic Induction (04 hrs)  
Production of e.m.f., idea of a transformer and its working principle
4. Transmission and Distribution System (08 hrs)  
Key diagram of 3 phase transmission and distribution system, Brief functions of accessories of transmission line. Difference between high and low voltage distribution system, identification of three-phase wires, neutral wire and earth wire in a low voltage distribution system. Identification of voltages between phases and between one phase and neutral. Difference between three-phase and single-phase supply. Arrangement of supply system from pole to the distribution board, function of service line, energy meter, main switch, distribution board
5. Domestic Installation (08 hrs)  
Various types of domestic circuits, various accessories and parts of domestic electrical installation. Identification of wiring systems, staircase installation



6. Electric Motors and Pumps (10 hrs)

Definition and various applications of single-phase and three-phase motors. Connection and starting of three-phase induction motors by star-delta starter. Conversion of horse power in watts or kilowatts, Type of pumps and their applications, difference between direct online starter and star delta starter, characteristics and applications of servo motors.

7. Electrical Safety (04hrs)

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

8. Basic Electronics (06hrs)

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

### **LIST OF PRACTICALS**

1. Connection of a three-phase motor and starter with fuses and reversing of direction of rotation
2. Connection of a single-phase induction motor with supply and reversing of its direction of rotation
3. To test a battery for its charged and discharged condition.
4. Identify the different faults in a domestic wiring system
5. Connection and reading of an electric energy meter with supply and load using ammeter, voltmeter, wattmeter
6. Study of a distribution board for domestic installation
7. Ohm's law verification
8. Verification of law of resistance in series
9. Verification of law of resistance in parallel
10. Draw V-I characteristics of P-N junction diode
11. Draw input and output characters of a transistor
12. Draw reverse break down characteristics of a zener diode

### **INSTRUCTIONAL STRATEGY**

The teacher should give emphasis on understanding of concept and various terms used in the subject. Practical exercises will reinforce various concepts.

## RECOMMENDED BOOKS

1. Basic Electrical Engineering by PS Dhogal; Tata McGraw Hill Publishers, New Delhi
2. A Text Book of Electrical Technology, Vol. I and II by BL Thareja; S Chand and Co., New Delhi
3. Basic Electricity by BR Sharma; Satya Prakashan, New Delhi
4. Basic Electrical Engineering by JB Gupta, S Kataria and Sons, Delhi
5. Experiments in Basic Electrical Engineering by SK Bhattacharya and KM Rastogi, New Age International Publishers Ltd., New Delhi
6. Basic Electronics by VK Mehta; S Chand and Co., New Delhi
7. Electrical Machines by SK Bhattacharya; Tata McGraw Hill, New Delhi

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	4	10
2	4	10
3	4	10
4	8	15
5	8	15
6	10	18
7	4	10
8	6	12
<b>Total</b>	<b>48</b>	<b>100</b>

### 3.4 WORKSHOP TECHNOLOGY-1

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#### RATIOANELE

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. Welding (16 hrs)
  - 1.1 Welding Process  

Principle of welding, Classification of welding processes, Advantages and limitations of welding, Industrial applications of welding, Welding positions and techniques, symbols.
  - 1.2 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
  - 1.3 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
  - 1.4 Other Welding Processes
    - Resistance welding, introduction to spot and seam welding
    - Modern welding methods – TIG, MIG, ultrasonic welding, laser beam welding, robotic welding
  - 1.5 Welding Defects  

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

2. Pattern Making (03 hrs)

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

3. Moulding and Casting (16 hrs)

3.1 Moulding Sand

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

3.2 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.

3.3 Casting Processes

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

3.4 Gating and Riser System

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

3.5 Melting Furnaces

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

3.6 Casting Defects

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

4. Metal Forming Processes (08 hrs)
- 4.1 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
  - 4.2 Forging - Open die forging, closed die forging, Press forging, upset forging, swaging, up setters, roll forging, Cold and hot forging
  - 4.3 Rolling - Elementary theory of rolling, Types of rolling mills, Thread rolling, roll passes, Rolling defects and remedies
  - 4.4 Extrusion and Drawing - Type of extrusion- Hot and Cold, Direct and indirect. Pipe drawing, tube drawing, wire drawing
5. Plastic Processing (05 hrs)
- 5.1 Industrial use of plastics, situation where used.
  - 5.2 Injection moulding-principle, working of injection moulding machine.
  - 5.3 Compression moulding-principle, and working of compression moulding machine.
  - 5.4 Potential and limitations in the use of plastics

### **INSTRUCTIONAL STRATEGY**

1. Teachers should lay special emphasis in making the students conversant with concepts, principles, procedures and practices related to various manufacturing processes.
2. Focus should be laid in preparing jobs using various machines/equipment in the workshop.
3. Use of audio-visual aids/video films should be made to show specialized operations.

### **LIST OF RECOMMENDED BOOKS**

1. Workshop Technology by BS Raghuvanshi : Dhanpat Rai and Sons Delhi
2. Elements of Workshop Technology by SK Choudhry and Hajra : Asia Publishing House
3. Manufacturing Technology by M Adithan and A.B. Gupta; Wiley Eastern India Ltd. New Delhi.
4. Welding Engineering by RL Aggarwal and T Manghnani; Khanna Publishers, Delhi
5. A Text Book of Production Engineering by PC Sharma; S Chand and Company Ltd. Delhi
6. Foundry Technology by KP Sinha and DB Goel; Roorkee Publishing House, Roorkee.

7. A Text Book of Manufacturing Science and Technology by A Manna, Prentice Hall of India, Delhi.

**SUGGESTED DISTRIBUTION OF MARKS**

<b>Topic No.</b>	<b>Time Allotted (Hrs)</b>	<b>Marks Allotted (%)</b>
1	16	32
2	03	08
3	16	32
4	08	18
5	05	10
<b>Total</b>	<b>48</b>	<b>100</b>

### 3.5 MACHINE DRAWING

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- - 6

#### RATIONALE

Diploma holders in Mechanical Engineering are required to interpret drawings and therefore it is essential that they have skills of preparing drawings and sketches of mechanical components. This subject aims at development of drawing skills in the students.

#### DETAILED CONTENTS

1. Limits and fits (03 sheets)  
Maximum limit of size, minimum limit of size, tolerance, allowance, deviation, upper deviation, lower deviation, fundamental deviation, clearance, maximum clearance, minimum clearance. Fits – clearance fit, interference fit, transition fit. Hole basis system, shaft basis system, tolerance grades, calculating values of clearance, interference, hole tolerance, shaft tolerance with given basic size for common assemblies like H<sub>7</sub>/g<sub>6</sub>, H<sub>7</sub>/m<sub>6</sub>, H<sub>8</sub>/p<sub>6</sub>
2. Introduction to drawing office equipment through a visit to modern drawing office of an industry.
3. Drawing of the following with complete dimensions, tolerances, materials and surface finish marks.
  - 3.1 Universal coupling (Assembly) and Oldham coupling (02 Sheets)
  - 3.2 Bearings (04 sheets)
    - 3.2.1 Bushed Bearing (Assembled Drawing)
    - 3.2.2 Ball Bearing and Roller Bearing (Assembled Drawing)
    - 3.2.3 Plummer Block ( Assembled Drawing)
    - 3.2.4 Foot step Bearing (Assembled Drawing)
  - 3.3 Pulleys (01 sheet)  
Fast and loose pulley (Assembled Drawing)
  - 3.4 Pipe Joints (02 sheets)
    - 3.4.1 Expansion pipe joint (Assembly drawing)
    - 3.4.2 Flanged pipe and right angled bend joint (Assembly Drawing)
  - 3.5 Lathe Tool Holder (Assembly Drawing) (01 sheets)
  - 3.6 Reading of mechanical components drawings (01 sheets)
  - 3.7 Sketching practice of bearing, bracket and pulley. (02 sheets)

4. Drilling Jig (Assembly) (01 sheet)
5. Machine Vice (Assembly) (01 sheet)
6. IC Engine Parts (03 sheets)
  - 6.1 Piston and ring (assembly drawing)
  - 6.2 Connecting rod (assembly drawing)
  - 6.3 Crank shaft and flywheel (assembly drawing)
7. Mechanical Screw Jack (assembly drawing) (01 sheet)

- Note:-**
- (1) First angle projection should be followed, 20% of drawings may be prepared in third angle projection.
  - (2) SP-46-1988 should be followed
  - (3) The drawing should include discussion with tolerances, whenever necessary and material list as per BIS / ISO specifications.

### **INSTRUCTIONAL STRATEGY**

1. Teachers should show model or realia of the components/part whose drawing is to be made
2. Emphasis should be given to cleanliness, dimensioning, layout of sheet
3. Teachers should ensure use of IS codes related to drawing
4. Focus should be on the proper selection of drawing instrument and its proper use

### **LIST OF RECOMMENDED BOOKS**

1. Machine Drawing by P.S. Gill; S.K. Kataria and Sons; Ludhiana
2. A Text Book of Machine Drawing by R.K.Dhawan; S. Chand and Co. Ltd New Delhi.
3. Machine Drawing by N.D. Bhatt; Charotar Book Depot. Anand.



### 3.6 WORKSHOP PRACTICE - I

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- - 9

#### LIST OF PRACTICALS

General introduction to hand tools used in foundry, welding and pattern making and smithy shop.

#### **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 gas welding of cast iron and brass part or component.
- Job 4. Exercise on preparation of T Joint by arc welding
- Job 5. Exercise on spot welding/seam welding
- Job 6. Exercise 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
- Job 5. Preparation of a core box.

#### **Foundry Shop**

- Job 1. Preparation of mould with solid pattern on floor.
- Job 2. Preparation of floor mould of solid pattern using cope.
- Job 3. Preparation of floor mould of split pattern in cope and drag of moulding box.
- Job 4. Moulding and casting of a solid pattern of aluminum
- Job 5. Preparing a mould of step pulley and also preparing core for the same.
- Job 6. A visit to cast iron foundry should be arranged to have first hand knowledge of cast iron melting pouring and casting.
- Job 7. Testing of moisture contents and strength of moulding sand.

#### **Forging Shop/Fitting Shop/Sheet Metal Shop**

- Job 1. Preparation of single ended spanner by hand/machine forging.
- Job 2. Preparation of simple die
- Job 3. Demonstration of spinning process on lathe and spinning a bowl on a lathe machine.
- Job 4. Demonstration of grinding process on lathe machine and grinding a job on a lathe machine
- Job 5. Preparation of utility item out of G.I. sheet.
- Job 6. Preparation of drilling Jig.