4.1 Strength of Materials

L T P
4 - 2

RATIONALE

Diploma holders in this course are required to analyses reasons for failure of different components and select the 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. Hence this subject has been introduced.

DETAILED CONTENTS

1. Introduction to Material Properties **03 Period**

Mechanical properties of materials such as elasticity, plasticity, ductility, brittleness, toughness, hardness, fatigue, malleability, stiffness. Elastic bodies, plastic bodies and rigid bodies, deformation.

2. Stresses and Strains **08 Period**

2.1 Force, its definition and types, units, different types of loads.
2.2 Definition of stress and strain, axial loading, different types of stresses and strains, tensile and compressive stress and strain, elastic limit, Hooke's law, stress-strain curve for ductile and brittle material, salient features of stress-strain curve. Young's modulus of elasticity
2.3 Factor of safety.
2.4 Stress and strain in straight, stepped bars and taper bar of circular cross section, determination of stress and elongation of a bolt in a bolted joint when subjected to direct external load only
2.5 Stress and strain on composite section under axial loading, stress and strain due to temperature variations in homogeneous and composite bars.
2.6 Shear load, shear stress and strain, modulus of rigidity, lateral strain, Poisson's ratio
2.7 Volumetric strain, bulk modulus. Relation between modulus of elasticity, modulus of rigidity and bulk modulus

3. Shear Force and Bending Moment **06 Period**

3.1 Types of beams.
3.2 Concept of shear force and bending momen.
3.3 Shear force and bending moment diagram for cantilever and simply supported beams subjected to point load and uniformly distributed loads only. Maximum bending moment and point of contraflexure.

4. Theory of Simple Bending **06 Period**

4.1 Concept of pure bending, neutral axis, moment of resistance, section Modulus, bending equation, bending of simple, beams of uniform strength.
4.2 Application of flexural formula for solid rectangular and circular section, Channel section, hollow rectangular and circular section.

5. Strain Energy **06 Period**

5.1 Concept of strain energy, proof resilience and modulus of resilience.
5.2 Stresses developed due to gradual, sudden and impact load.
5.3 Strain energy stored due to gradual, sudden and impact load.
5.4 Strain energy due to bending and torsion.

6. Slope and Deflection **06 Period**

6.1 Introduction, determination of slope and deflection by Macaulay's method, moment area of method
6.2 Simple cases of slope and deflection in simply supported beam with uniformly distributed load on whole of the length and a point load at the centre
6.3 Cantilever beam with uniformly distributed load on whole length and a point load at the end.

7. Torsion **05 Period**

7.1 Pure torsion, torsion equation (relation between twisting moment, shear stress and angle of twist), polar modulus of section
7.2 Assumptions in theory of pure torsion
7.3 Strength of circular solid shaft and hollow shaft in pure torsion
7.4 Power transmitted by shaft

8. Springs **05 Period**

8.1 Effect of falling load helical spring
8.2 Helical Springs closed coiled and open coiled helical springs subjected to axial load
8.3 Angle of twist, strain energy, shear stress and maximum deflection under axial load
8.4 Laminated spring (semi-elliptical and quarter-elliptical type), deterination of number of plates, maximum deflection under axial load

9. Thin Cylinder and spheres **07 Period**

9.1 Introduction
9.2 Thin cylinder Vessel Subjected to internal Pressure
9.3 Stresses in a Thin cylinder Vessel Subjected to internal Pressure
9.4 Expression for circumferential stresses
9.5 Expression for longitudinal stresses
9.6 Stresses in a Thin cylinder Vessel Subjected to internal Pressure and external pressure
9.7 Stresses in a thin sphere shells subjected to internal Pressure

10. Riveted Joints **06 Period**

10.1 Introduction
10.2 Types of rivets joints
10.3 Failure of riveted joints
10.4 Strength of the riveted joints
10.5Efficiency of riveted joints

11. Columns and struts **06 Period**

11.1 Definition, Types of column
11.2 Buckling load, crushing load
11.3 Slenderness ratio.
11.4 Factors affecting strength of column
11.5 Euler's formula for long columns
11.6 End restraints, effective length for different end conditions
11.7 Rankine Gourdan formula
11.8 Direct and eccentric loading with stress diagram
11.9 Direct and bending stresses and their combination

LIST OF PRACTICALS

1. Perform tensile test on bars of mild steel and aluminum.
2. Perform shear test on specimen of two different metals.
3. Carry out bending tests on a steel bar or wooden beam.
4. Perform following impact test:
   (a) Izod impact test
   (b) Charpy test
5. Perform torsion test on specimen of different metals for determination of angle of twist for a given torque.
6. Determine the stiffness of a helical spring and to plot a graph between load and extension.
7. Perform hardness test on metal and finding the Brinell hardness, Rockwell hardness and Vicker's hardness.

INSTRUCTIONAL STRATEGY

1 Use computer based learning aids for effective teaching-learning
2 Expose the students to real life problems.
3 Plan assignments so as to promote problem solving abilities and develop continued learning skills.

RECOMMENDED BOOKS

1. Strength of Materials by Srivatava & Gope, PHI Publication.
1. Strength of Materials by R.S. Khurmi; S. Chand and Company, Delhi.
2. Strength of Materials by S. Ramamurtham; Dhanpat Rai Publishing Co.(P) Limited, Delhi.
3. Mechanics of Materials by Kirpal Singh; Standard Publishers, New Delhi.
4. Elements of Strength of Materials by D.R. Malhotra and H.C, Gupta; Satya Parkashan, New Delhi.
5. Mechanics of Solids by VS Prasad; Galgotia Publications, New Delhi.
6. Strength of materials Dr. B.C Puniya & S.Rama Murthi; Laxmi Publication, New Delhi.
7. Mechanics of solids by J.K.Kapoor; Bharat Bharati Prakashan, Meerut

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1.	03	05
2.	08	10
3.	06	10
4.	06	10
5.	06	10
6.	06	10
7.	05	10
8.	05	05
9.	07	10
10.	06	10
11	06	10
Total	**64**	**100**

4.2 APPLIED THERMAL ENGINEERING

L	T	P
4	-	2

RATIONALE

Thermal energy is still a major means of power in the world. Knowledge of thermal contrivances and related principle is very essential for mechanical diploma holders. The subject presents an introduction to sources of heat, thermodymics principles and their applications to thermal contrivances.

DETAILED CONTENTS

1. IC Engines **14 Period**

1.1 Introduction and classification of IC engine
1.2 Working principle of two stroke and four stroke cycle, SI engines and CI engines, Otto cycle, Diesel cycle and dual cycle
1.3 Location and functions of various parts of IC engines and materials used for them
1.4 Concept of IC engine terms: bore, stroke, dead centre, crank throw, compression ratio, clearance volume, piston displacement and piston speed, working of carburettor, mixture requirements, carburetor types, simple numerical problems concerning the above.

2. Cooling and Lubrication **04 Period**

2.1 Function of cooling system in IC engine
2.2 Air cooling and water cooling system, use of thermostat, radiator and forced circulation in water cooling (description with line diagram)

3. Testing of IC Engines **10 Period**

3.1 Engine power - indicated and brake power
3.2 Efficiency - mechanical, thermal. relative and volumetric
3.3 Methods of finding indicated and brake power, Morse test.
3.4 Morse test for petro1 engine
3.5 Heat balance sheet
3.6 Concept of pollutants in SI and CI engines, pollution control, norms for two or four wheelers - EURO standards, methods of reducing pollution in IC engines, alternative fuels like CNG, LPG (Simple numerical problems)

4. Fundamentals of Refrigeration **04 Period**

Introduction to refrigeration and air conditioning, units of refrigeration, meaning of refrigerating effect, compressor work, condenser work and COP, difference between COP and efficiency, methods of refrigeration, natural system and artificial system of refrigeration (Simple numerical problems)

5. Vapour Compression System **06 Period**

Principle, function, parts and necessity of vapour compression system, T- ϕ and p– H charts, dry, wet and superheated compression. Sub cooling, super heating, mass flow rate, entropy, enthalpy, work done, refrigerating effect and COP. actual vapour compression system (Simple numerical problems)

6. Refrigerants **03 Period**

Functions, various classification of refrigerants, properties of R - 717, R – 22, R–134 (a), CO_2, R – 11, R – 12, R – 502, Properties of ideal refrigerant, selection of refrigerant

7. Vapour Absorption System **04 Period**

Introduction, principle, NH_3 absorption system, lithium bromide absorption system, domestic electrolux system, analysis of vapour absorption system, solar power refrigeration system, advantages and disadvantages of solar power refrigeration system over vapour compression refrigeration system (Simple numerical problems)

8. Refrigeration Equipment **08 Period**

8.1 Compressors

Function, various types of compressors, volumetric efficiency, power for single stage compressor, intermediate pressure for multistage compressor for maximum power, performance characteristics

8.2 Condensers

Function, various types of condensers, essential requirements of a condenser, water cooled and air cooled condensers, free and forced convection condensers, fouling factor, heat rejection factor, overall heat transfer coefficient

8.3 Evaporators

Function, DX and flooded evaporator, advantages and disadvantages, other types of evaporators

8.4 Expansion Valves

Function, various types such as capillary tube, thermostatic expansion valve, low side and high side float valves, application of various expansion valves

AIR CONDITIONING

9. Psychrometry **03 Period**

Definition, importance, specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, humid heat, latent heat, relationship amongst them.

10. Applied Psychrometry and Heat Load Estimation. **06 Period**

Psychrometric chart, various lines, psychrometric process, by pass factor, room sensible heat factor, effective room sensible heat factor, ADP, room DPT, supply air condition, different heat sources for calculation of heat load, factors which contribute towards load of an air conditioning room (Simple numerical problems)

LIST OF PRACTICALS

1. Study of working principle of two/ four stroke petrol engines.
2. Study of simple/ compound carburetor.
3. To determine brake horse power by dynamometer.
4. To determine indicated horse power of a multicylinder petrol/diesel engine.
5. To prepare that balance sheet of diesel/ petrol engines
6. To study a vapour compression/ absorption refrigeration system
7. Study a cold storage through a visit
8. Study a room air conditioner
9. Study of cooling system of I.C. engines
10. Study of lubrication system of four stroke I.C. engine

INSTRUCTIONAL STRATEGY

1. Models of various components/ parts should be demonstrated to develop comprehension amongst students
2. Industrial visit to thermal power plant and roadways/ private automobile workshop should be arranged

3. Video films for demonstration of working of IC engines, jet propulsion and gas turbine should be shown.

RECOMMENDED BOOKS

1. Elements of heat engines by Pandey and Shah; Charotar Publishing house, Anand
2. Thermal Engineering by PL.Ballaney; Khanna Publishers, New Delhi.
3. Engineering Thermodynamics by Francis F Huang; McMillan Publishing company, Delhi.
4. Engineering Thermodynamics by CP Arora; Tata Mc Graw Hill Publishers, New Delhi.
5. Thermal engineering by RK Purohit; Standard publishers Dustributors, New Delhi.
6. Refrigeration and air conditioning by Domkundwar; Dhanpat Rai & sons, Delhi.
7. Refrigeration and air conditioning by CP Arora , Tata McGraw Hill , New Delhi.
8. Refrigeration and air conditioning by R.S Khurmi and J.K Gupta; S Chand and Company Limited, New Delhi

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SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1.	**14**	**20**
2.	**04**	**05**
3.	**10**	**15**
4.	**04**	**05**
5.	**06**	**10**
6.	**03**	**05**
7.	**04**	**05**
8.	**10**	**20**
9.	**03**	**05**
10.	**06**	**10**
Total	**64**	**100**

4.3 BASIC CIVIL ENGINEERING

L	P
3	4

THEORY

1- Construction material

Basics of various construction materials such as stones,bricks,lime,cement,steel and timber along with their properties, physical/field testing and uses, elements of brick and stone masonry. **(08 Period)**

2- Foundations Engineering

I) Various types of soil

II) Bearing capacity of soil and its importance

III) Types of various foundations for heavy, light and vibrating machines **(08 Period)**

3- Basic concept of concrete

Various ingredients of concrete, physical properties of aggregate as constituent material of concrete, different grade of concrete, water cement ratio, workability, physical/field testing of concrete, mixing of concrete , Introduction to IS: 456-2000, IS: 800-2007 and NBC 2005 (SP-7: 2005) **(08 Period)**

4- RCC

Basics of reinforced cement concrete and its use (elementary knowledge), introduction to various structural elements of a building, design of plain concrete strap footing. **(06 Period)**

5- Steel structure

Various types of steel, various rolled steel sections and their properties, use of steel table, introduction to riveted and welded connections. **(06 Period)**

6- Environmental engineering

Various sources of water, parameters related to qualities of portable water, impurities in water, introduction to various methods of water treatment. **(04 Period)**

7- Surveying

Introduction to surveying, representation to scale, introduction to chain surveying, traversing and plain table surveying , introduction to leveling , introduction to contouring and its properties. **(08 Period)**

PRACTICAL EXERCISES IN CIVIL ENGINEERING

1- Testing of bricks:

(a) Shape & Size

(b) Soundness Test

(c) Water Absorption

(d) Crushing Strength

2- Testing of Concrete:

(a) Slump Test

(b) Compressive Strength of concrete cube.

3- Testing of Aggregates:

(a) Impact Test
(b) Abrasion Test

4- Testing of Sand:

(a) Field test of physical impurities of sand

5- Testing on Steel:

(a) Tensile Strength Test of steel bars

6- Surveying Test:

(a) Ranging with rod
(b) Determination of reduced level (R.L.) of a point using Dumpy Level.
(c) Measurement of bearings & internal angles of a traverse using Prismatic Compass.

7- The students should be taken to different construction sites to show them various construction materials, concreting process & construction of RCC structural elements, foundations & other civil works.

REFERENCES

1- Building Materials

(a) S.K. Duggal: Building Materials, New Age International Publishers
(b) P.C. Varghese: Building Materials, PHI

2- Foundation Engineering

(a) Gopal Ranjan & Rao, A.S.R., "Basics of Applied Soil Mechanics", New Age International Publishers.
(b) B. C. Punmia, "Soil Mechanics & Foundations", Laxmi Publications

3- Basics concept of Concrete

(a) M. S. Shetty " Concrete Technology": S Chand Publication
(b) Neville A.M.,: "Properties of Concrete", Pitman Publishing Company

4- Reinforced Cement Concrete

(a) A.K. Jain, " Reinfored Concrete", Nem Chand & Bros
(b) O.P. Jain & J. Krishna, " Plain & Reinforcement Concrete", Nem Chand & Bros

5- Steel Structures

(a) S.K. Duggal, "Steel Structures", TMH
(b) S.S. Bhavikatti, "Steel Structures", I.K. International Publishing House Pvt. Ltd.

6- Environmental Engineering

(a) S.K. Garg, " Water Supply Engineering",Khanna Publishers

7- Surveying

(a) S.K. Duggal, " Surveying Vol. I", TMH
(b) B.C Punmia," Surveying &Levelling", Laxmi Publication
(c) K.R Arora," Surveying Vol. I", Standard Book House, Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1.	08	20
2.	08	20
3.	08	20
4.	06	10
5.	06	10
6.	04	05
7.	08	15
Total	48	100

4.4 PRODUCTION TECHNOLOGY

L T P
4 -0- 6

RATIONALE

This subject provides knowledge and develops skills on various machine operations viz capstan and turret Lathe, milling, grinding, gear manufacturing, broaching and automatic machines which is very essential for Mechanical diploma holders to work in manufacturing industries.

DETAILED CONTENTS

UNIT-1: **08Period**

1. Introduction ,study and uses of Capstan and Turret Lathe , Turret indexing mechanism, Bar feeding mechanism, Work holding devices and Tool holding devices –Jaw and collet chucks –Slide tool holder, Knee tool holder, knurling tool,holder, recessing tool holder, form tool holder, tap and die holder, V - steady box tool holder, roller steady, box tool holder, bar stops.

UNIT-2: **12Preiod**

Introduction tooling layout,Comparison of capstan, turret and conventional lathe. Specification, Classification and working principle of milling machine applications of milling machines, up milling and down milling, Milling operations –face milling, angular milling, form milling, straddle milling and gang milling.

UNIT-3: **12Period**

Grinding , Various elements of grinding wheel –Abrasive, Grade, structure, Bond, Grinding methods – Surface grinding, cylindrical grinding and centre less grinding. Gear Manufacturing Processes , Gear hobbing, Gear shaping, Broaching , 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.

UNIT-4: 12 Period

Metal Forming Processes, Press Working, 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, Forging, Open die forging, closed die forging,Press forging,

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

UNIT-5: 10 Period

UNCONVENTIONAL MACHINING PROCESSES-Introduction, principle, process and application of Ultrasonic machining (USM) ,Electro chemical machining (ECM) ,Electro chemical Grinding (ECG), Electrical Discharge Machining (EDM), Laser beam machining (LBM), Electro beam machining (EBM), Plasma arc machining (PAM)

Importance and use of jigs and fixture Principle of location, Types of Jigs –Drilling jigs, bushes, template jigs, plate jig, channel jig,

UNIT-6: 10 Period

Fixture for milling Advantages of jigs and fixtures, Plastic Processes Injection Blow moulding –working principle, advantages and limitations, Compression moulding ,Metallic and Non Metallic Coating Processes, powder process, Metal Finishing Processes, Lapping process, lapping compounds and tools, Brief idea of lapping machines, Super finishing process, its applications. Production of metal powders, sintering and finishing operations and extrusion Advantages, limitations and applications of powder metallurgy.

PRACTICAL EXERCISES

1. Preparation of a drilling jig.

2. Preparation of a milling fixture.

3. Exercise on milling- slab milling, Gang milling and straddle milling

4. To produce a gearby indexing device on a millingmachine

5. Preparing job on following machines:-a) Surface grinder ,b) Cylindricalgrinder

6. Exercise on tool and cutter Grinder

a) To grind Lathe tools

b) To grind a drill bit

c) To grind a milling cutter

INSTRUCTIONAL STRATEGY

1. Teaches should lay special emphasis in making the students conversant with concept, principle, procedure and practices related to various manufacturing processes

2. Focus should be laid on preparing jobs using various machines/ equipment in the workshop

3. Aids/ Video films should be used to show operations

RECOMMENDED BOOKS

1. Manufacturing technology by Rao; Tata McGraw hill Publishers, New Delhi
2. Manufacturing technology by M. Adithan and AB. Gupta; New Age International (P) Ltd, New Delhi
3. Workshop Technology vol I, II, III by Champman; Standard publishers Distributors
4. Practical hand book for Mechanical Engineers by AB Gupta; Galgotia publications, New Delhi
5. Fundamentals of metal cutting and machine tools by Juneja and Sekhon; Wiley Eastern Ltd., New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1.	08	15
2.	12	20
3.	12	20
4.	12	15
5.	10	15
6.	10	15
Total	64	100

4.5 MATERIAL SCIENCE AND METALLURGY

L T P
4 – 3

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 Engineering Materials has been designed to cover the above aspects.

DETAILED CONTENTS

1. Importance of Materials **08 Period**

1.1 Classification: Metals and non-metals, Ferrous and non-ferrous metals and their alloys.
1.2 Crystalline and non-crystalline structures; unit cells, Bravais space lattices, cubic closed pack structures, coordination number, miller indices, crystallographic planes and directions.
1.3 Structural imperfections- point, line, planar and volume defects, structure property relationship.
1.4 Names of common metals, their alloys and non-metals used in Industry
1.5 Properties of metals and alloys
1.6 Physical properties - Appearance, luster, colour, density and melting point
1.7 Thermal and electrical conductivity
1.8 Corrosion, causes, effects and prevention.
1.9 Study of creep and fatigue.

2. Ferrous Metals and Alloys **12 Period**

2.1 Flow diagram for the production of ferrous metals from their ores, constituents of iron, iron carbon diagram.
2.2 Classification, composition and uses of cast iron and plain carbon steels. IS, BS and SAE Grades
2.3 Effect of alloying elements such as Aluminium, chromium, Nickel, Cobalt, Manganese, Molybdenum, tungsten, Vanadium, Silicon, Sulphur and Phosphorous on steels.
2.4 Composition, properties, and uses of special steels such as High speed steel, Stainless steels, Silicon steels, Heat resistant steels, Spring steel.
2.5 Heat Treatment: Iron-carbon diagram, objectives of heat treatment. Brief description and uses with examples of principal heat treatment processes,
Annealing, Normalizing, Tempering, Hardening, Carburising, Nitriding and Cyaniding and applications, case hardening

3. Iron Carbon Equilibrium Diagram **(02 Period)**
3.1 Phase transformation
3.2 Nucleation and growth

4. T-T-T Diagram **02 Period**

4.1 Importance of critical cooling rate.
4.2 Martensite transformation
4.3 Nucleation and growth

5. Non-ferrous Metals and Alloys **12 Period**

5.1 Copper: Properties and uses
5.2 Composition, properties and uses of copper alloys.
5.3 Brasses: Cartridge brass, Nickel silver
5.4 Bronzes: Phosphor bronze, Al-bronze, Mn-bronze, and Gun metal.
5.5 Properties and uses of Aluminium.
5.6 Composition, properties and uses of Al-alloys e.g., Duralumin, Yellow metal, Magnalium and Hindalium
5.7 Properties and uses of alloys of lead, tin and magnesium.
5.8 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 trimetallic bushes

6. Identification and Examination of Metals and Alloys **02 Period**

Microscope principle and methods, Identification tests - Appearance, sound, filing, weight, magnetic, spark, bend and
microstructure.

7. Other Important Materials **10 Period**

7.1 Plastics: Definition, classification of plastics, fibre glass, reinforced plastics. Major applications of various plastics and their uses and grades.
7.2 Composite materials.
7.3 Heat insulating materials: Properties and uses of asbestos, glass wool, thermo Cole, cork, mica.
7.4 Electrical insulating materials. Properties and uses of china clay, leather, bakelite, ebonite, glass wool, rubber, felt.
7.5 Sound insulating materials: Cork, fibre boards.
7.6 Fabrication materials: Wood, plywood, rubber – natural and synthetic, Glass – plate glass, toughened glass, safety glass.
7.7 Refractory materials: General characteristics and uses of dolomite, ceramics.
7.8 Protective coating materials: Paints, primers, varnishes, enamels, putti, electroplating materials, rubasil, Teflon coating.
7.9 Sealant and adhesives – Application and availability of sealant and adhesives for industrial user.
7.10 Smart materials.

8. Diffusion **02 Period**

Ficks Laws of Diffusion and practical examples

9. Powder Metallurgy and Mechanical Working of Metals **08 Period**

9.1 Introduction of powder metallurgy
9.2 Advantage and limitations of powder metallurgy
9.3 Powder metallurgy processes
9.4 Principles of hot and cold working
9.5 Effect on properties and limitations

10. Selection, specifications and commercial availability of materials **06 Period**

10.1 Practical considerations for selection of material for different purposes
10.2 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 into

   - Metals and Non Metals
   - Metals and Alloys
   - Ferrous and non ferrous metals
   - Ferrous and non ferrous alloys

2. Given a set of specimen of metals and alloys (copper, brass, aluminum, cast iron, HSS, Gun metal), identify and indicate the various properties possessed by them
3. Study of heat treatment furnace
4. Study of metallurgical microscope and a specimen polishing machine.
5. To prepare specification of following materials for microscopic examination and to examine the micro structure of 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 given specimen to find out the difference in hardness as a result of tempering
9. Study of Ball Mills used in preparation of powder.
10. Study of Pallet Press.

INSTRUCTIONAL STRATEGY

While imparting instructions, teacher should show various types of engineering materials to the students. Students should be asked to collect samples of various materials available in the market. Visits to industry should be planned to demonstrate use of various types of materials in the industry.

RECOMMENDED BOOKS

1. Material Science by R.K.Rajput; Laxmi Publications, Darya Ganj, New Delhi.
2. Advances in material Science by R.K.Dogra and Dr.A.K.Sharma;S.K.kataria & sons; New Delhi.
3. Material Science by GBS Narang; Khanna Publishers New Delhi
4. Material Science and Metallurgy by D.S. Nutt. SK Kataria and Sons, Delhi.
5. Material Science and Engineering by Dr. P.L Shah

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1.	08	10
2.	12	20
3.	02	05
4.	02	05
5.	12	20
6.	02	05
7.	10	10
8.	02	05
9.	08	10
10.	06	10
Total	64	100

4.6 METROLOGY

L T P
4 - 4

RATIONALE

Diploma holders in these courses are required to measure and inspect for ensuring quality of product. For this purpose, knowledge and skills about standards of measurement, limit, fits and tolerances, types of inspection and various measuring instruments are required. Hence this subject is offered

DETAILED CONTENTS

1. Introduction **06 Period**

1.1 Definition of metrology
1.2 Standard of measurement - Primary, secondary, Tertiary and working standards.
1.3 Types of errors- Controllable and random errors
1.4 Precision, accuracy, sensitivity, hysterisis, response time, repeatability, calibration, uncertainty of measurement

2. Linear Measurement **10 Period**

2.1 Construction features and use of instruments for non precision linear measurement: steel rule, callipers, surface plate, angle plate, V-block.
2.2 Construction features and use of instruments for precision measurements : vernier calipers, vernier height and depth gauges, micrometers.
2.3 Slip gauges, Indian standards of slip gauges, sets of slip gauges, use of slip gauges.
2.4 Cylinder bore gauges, feeler and wire gauges.
2.5 Comparators – Characteristics, uses, working principles of different types of comparators: mechanical, electrical, electronics and pneumatic comparator.

3. Angular Measurement **09 Period**

3.1 Construction and use of instruments for angular measurements: bevel Protector, sine bar, angle gauges, clinometers.
3.2 Optical instruments for angular measurement, autocollimator. Angle dekkors
3.3 Circular divisions - optical dividing heads, circular dividing engine, rotary tables, other instruments

4. Measurement of Surface Finish **08 Period**

4.1 Terminology of surface roughness.
4.2 Concept of primary texture and secondary texture.
4.3 Factors affecting surface finish.
4.4 CLA, RMS and RA value.
4.5 Principle and operation of stylus probe instruments for measuring surface Roughness

5. Measurements of Screw threads and Gears **08 Period**

5.1 Measurement of screw threads- Introduction, measurements of external and core diameters, checking of pitch and angle of threads with gauges.
5.2 Effective diameter measurement by three wire method.
5.3 Measurements of gears (spur) – Measurement of tooth thickness, pitch, testing of alignment of teeth.
5.4 Profile projector, Coordinate Measuring Machine (CMM), Tool maker's microscope.

6. Machine Tool Testing **08 Period**

6.1 Alignment test on lathe, drilling machine and milling machine.

7. Limits, Fits and Tolerances **07 Period**

7.1 Definition and terminology of limits, fits and tolerances.
7.2 Interchangeability
7.3 Hole basis and shaft basis systems.
7.4 Type of fits.
7.5 Standard and Limit gauges.

8. Instrumentation **08 Period**

8.1 Brief description about the measurement of displacement, vibration, frequency, pressure, temperature and humidity by electromechanical transducers

LIST OF PRACTICALS

1. Internal and external measurement with vernier - caliper and micrometer.
2. Measurement with height gauge and depth gauge.
3. Measurement of flatness with dial indicator.
4. Measurement with combination set and bevel protector.
5. Study and use of slip gauges.
6. Measurement of gear characteristics
7. Measurement of angle with sine bar and slip gauges
8. Measurement of worn out IC engine piston clearance between cylinder and piston.
9. Measurement of flatness using comparator.
10. Determination of temperature by (i) pyrometer (ii) thermocouple.
11. Use of feeler gauge, wire gauge, radius gauge and fillet gauges for checking of standard parameters.
12. Measurement of surface roughness of a surface

INSTRUCTIONAL STRATEGY

1. Demonstrate use of various measuring instruments while imparting theoretical instructions.
2. Stress should be laid on correct use of various instruments.

RECOMMENDED BOOKS

1. Engineering Metrology by RK Jain; Khanna Publishers, New Delhi.
2. A Text Book of Production Engineering by PC Sharma; S Chand and Company, New Delhi.

3. Metrology Laboratory Manual by M Adithan and R Bahl; NITTTR, Chandigarh.
4. Engineering Metrology by RK Rajput; SK Kataria and Sons, Ludhiana.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	6	10
2	10	18
3	9	14
4	8	12
5	8	12
6	8	12
7	7	10
8	8	12
Total	**64**	**100**

4.8 INDUSTRIAL TRAINING

Industrial training provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice.

For this purpose, students at the end of fourth semester need to be sent for industrial training for a minimum of 4 weeks duration to be organised during the semester break starting after IV Semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A teacher may guide a group of 4-5 students. A minimum of one visit by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

Internal assessment and external assessment have been provided in the study and evaluation scheme of V Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry, if any. 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%