4.1 Strength of Materials

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
10.5 Efficiency 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

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
.

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

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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

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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,

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 HYDRAULICS AND HYDRAULIC MACHINES

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RATIONALE

Diploma holders in Mechanical Engineering are required to deal with problems of fluid flow and use of hydraulics in power generation. For this purpose, knowledge and skill about fluid mechanics, fluid flow and hydraulic machines are required to be imparted for enabling them to perform above functions. This subject aims at development of knowledge and skills about various properties of fluids, measurement of various flow parameters and about various hydraulic machines.

DETAILED CONTENTS

1. Introduction   04 Period

Fluid, types of fluid; properties of fluid viz mass density, weight density (specific weight), specific volume, capillarity, specific gravity, viscosity, compressibility.

2. Pressure and its Measurement   06 Period
2.1 Concept of Pressure (Atmospheric Pressure, gauge pressure, absolute pressure)
2.2 Pressure measuring devices: peizometer tube, manometers - simple U-tube, differential single column, inverted U- tube, micromanometer
2.3 Bourdon tube pressure gauge
2.4 Simple problems

3. Flow of Fluids   06 Period

Types of fluid flow- steady and unsteady, uniform and non- uniform, laminar and turbulent; rate of flow and their units; continuity equation of flow; Bernoulli's theorem (without proof) and its applications, Discharge measurement with the help of venturimeter, orifice meter and pitot tube, simple problems

4. Notches and Weirs   06 Period

Different type of notches, Measurment of discharge over rectangular notch. Francis and Brazin's fomula for rectangular weirs, submerged weirs, broad crested weirs.

5. Flow through orifices   06 Period

Cc, Cv, Cd, flow through drowned, partially drowned orifices, time for emptying a tank through a circular orifice. Simple problems

6. Flow through pipes   06 Period

§ Definition of pipe flow, wetted perimeter, hydraulic mean depth, hydraulic gradient; loss of head due to friction; Chezy's equation and Darcy's equation of head loss.§ Loss of head in pipes due to sudden enlargement, sudden contraction, obstruction on flow path, change of direction and pipe fittings, Simple problems

7. Hydraulic Devices   06 Period

Description, operation and application of hydraulic machines –hydraulic ram, hydraulic jack, hydraulic brake, hydraulic accumulator, hydraulic door closer,

hydraulic press,

8. Water Turbines and Pumps   (08 Period)

Concept of a turbine, types of turbines – impulse and reaction. Construction and working of pelton wheel, Francis turbine and Kaplan turbine. Concept of hydraulic pump. Construction, working and operation of reciprocating pump and centrifugal pump.

LIST OF PRACTICALS

1. **Measurement of pressure head by employing**

i) Piezometer tube

ii) Single and double column manometer

iii) Pressure gauge

2. **To find out the value of coefficient of discharge for a venturimeter**

3. **Measurement of flow by using venturimeter**

4. **Verification of Bernoulli's theorem**

5. **To determine the coefficient of friction of pipe using Darcy's equation**.

6. **Study the working of a pelton wheel and Francis turbine**

7. **Dismantling and assembly of a single stage centrifugal pump to study its**

constructional details, operation including fault diagnosis.

8. **To demonstrate the working of a Kalpan Turbine.**

9. **To demonstrate the working of a single acting and double acting Reciprocating**

pump.

10. **To determine Cd, Cv and Cc for a orifice.**

RECOMMENDED BOOKS

1. Hydraulics and Hydraulic Machines by RS Khurmi ; S.Chand & Co. Ltd., New

Delhi.

2. Hydraulics and Fluid Mechanics by Jagdish Lal; Metropolitan Book Company

Ltd., Delhi.

3. Fluid Mechanic, Hydraulics and Hydraulic Machines by K.K. Arora; Standard

Publishers Distributors, Delhi.

4. Fluid Mechanics, Hydraulics and Fluid Machines by S. Ramamruthan; Dhanpat

Rai and Sons, Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1.	04	05
2.	06	14
3.	06	14
4.	06	10
5.	06	14
6.	06	14
7.	06	14
8.	08	15
Total	48	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%