METROLOGY & MEASUREMENT
(MECH 2105)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) Lower limit of diameter of a shaft can be quickly checked by suitable
   (a) 'GO' snap gauge   (b) Dial gauge
   (c) 'NO GO' snap gauge   (d) 'GO' plug gauge.

   (ii) A 100mm sine bar is used to measure angle of a component. Slip gauges having total height of 25 mm is put under the sine bar roller to make the top surface of the component horizontal. The angle of the component in degree is
   (a) 13.25   (b) 14.48   (c) 12.27   (d) 9.67.

   (iii) Measured value of "Span over 3 teeth" of a spur gear is function of it's
   (a) P.C.D
   (b) Module, Pressure angle & no. of teeth
   (c) Width
   (d) No. of teeth & module.

   (iv) A "Filler Gauge" is used
   (a) To fill up a gap
   (b) To measure shaft diameter
   (c) To measure corner radius
   (d) To measure gap between two mating surfaces

   (v) Which of the following is correct if the 5° angle block is reversed and combined with the 30° angle block
   (a) The resulting angle becomes 30°
   (b) Such a combination is not possible
   (c) The resulting angle becomes 25°
   (d) The resulting angle becomes 35°.

   (vi) Accuracy of measurement of an angle by a profile projector depends on
   (a) Least count of X & Y slides
   (b) Least count of circular scale on screen
   (c) Magnification of the shadow
   (d) Both (b) & (c).

   (vii) If the Fit between a shaft and hole is required to be close clearance fit, the dimension of the hole / shaft should be tolerated as
   (a) H7/d6   (b) H7/m6   (c) H7/g6   (d) M7/h6.

   (viii) For the same surface, value of Ra
   (a) Is always greater than Rrms   (b) Is always less than Rrms
   (c) Is always equal to Rrms   (d) Can be any of these.

   (ix) Main scale reading of a micrometer is 10 mm and reading on the thimble is 27. The pitch of the spindle screw is 0.50 mm and number of divisions on the thimble is 50. The actual measurement is
   (a) 12.70mm   (b) 10.27mm
   (c) 10.027mm   (d) 10.0027 mm.

   (x) LVDT is usually used for measuring
   (a) Displacement   (b) Pressure
   (c) Density   (d) Temperature.

Group – B

2. (a) Define the following with suitable sketches:
   (i) Flatness of a surface
   (ii) Roundness
   (iii) Cylindricity

   (b) Compute the slip gauge block combinations to build the following dimensions:
   (i) 18.09
   (ii) 113.385
   The slip gauge set M 38 consists of the following:

Range (mm)	Steps (mm)	Pieces
1.005		01
1.01-1.09	0.01	09
1.1-1.9	0.1	09
1.0-9.0	1.0	09
10.0-100.0	10.0	10

                                            6 + 6 = 12

3. (a) (i) With mathematical expression and proper diagram, explain why large radius of curvature is important in case of spirit level.

   (ii) What are the major differences when measuring gear tooth thickness using gear tooth callipers and tooth span micrometer respectively with advantages and limitations of each process?

   (b) Explain the reason behind generation of Newton's ring when using optical flat. What could be concluded by observing the pattern of Newton's ring? Explain with neat sketch.

   (3 + 4) + (3 + 2) = 12

Group – C

4. (a) Why hole basis system is preferred over shaft basis system for dimensional tolerance in industries?

   (b) Calculate the limits of tolerance, allowance, fundamental deviation and show it in a figure for 40 mm shaft and hole pair designated as $40H_8d_9$ type of fit. Size 40 mm falls in the diameter step 30 and 50 mm. Take $i = 0.45\sqrt[3]{D} + 0.001 D$ microns, IT8 = 25i, IT9 = 40i. Fundamental deviations for "d" type shaft is $(-16 D^{0.44})$ microns. Explain the use of plug gauge in industry.

   2 + (7 + 3) = 12

5. (a) Briefly explain with neat sketch the working principle of profile projector and use it to measure pitch of a hacksaw blade.

   (b) Describe briefly the working principle of a back pressure bourdon gauge pneumatic comparator and use it to check straightness of a plate.

   (4 + 2) + (4 + 2) = 12

Group – D

6. (a) What is the difference between Accuracy & Precision of an instrument?

   (b) What is the difference between Sensitivity & Threshold of an instrument?

   (c) Define a Primary Transducer and a Secondary Transducer with reference to a specific instrument.

   (d) Define an Active Transducer and a Passive Transducer with specific example of an instrument.

   3 + 3 + 3 + 3 = 12

7. (a) Calculate the CLA value of a surface for the following data:
   The sampling length is 0.7 mm, the graph is drawn to a vertical magnification of 10000 and horizontal magnification of 100 and the areas above and below the datum lines are 165, 90, 175, 55 mm² and 95, 70, 165, 155 mm² respectively.

   (b) (i) Explain R.M.S method and Ten Point Height method of surface finish measurement.

   (ii) Explain the principle of operation of a Talysurf.

   4 + (4 + 4) = 12

Group – E

8. (a) Derive the relationship between the applied strain and the corresponding change in resistance of a strain gauge.

   (b) A strain gauge is pasted in axial direction on the surface of a cylindrical steel rod. The strain gauge is connected to one leg of a Wheatstone Bridge.
   When an axial load is applied to the rod, the Wheatstone Bridge, to which the strain gauge is connected produced an output voltage $\Delta e_o = 10^{-6}$ volt. Calculate the axial load on the rod.
   Given:

Cross-section of the rod	= 100 mm²
Young's Modulus of the rod	= 2×10^5 N/mm²
Gauge Factor "F"	= 2
Input voltage to the Wheatstone Bridge ei	= 2 volt
Strain ϵ	= $4*\Delta e_o / (ei * F)$

   6 + 6 = 12

9. (a) Draw the graph of output voltage vs. core displacement of a LVDT and mark the linear range

   (b) Describe the two 'Laws of Thermocouple'.

   (c) Explain how these laws help
   (i) construction of Thermocouple
   (ii) measurement of temperature using Thermocouple table.

   3 + 3 + (3 + 3) = 12