(vii) Involute profile of a gear tooth can be checked by
(a) Optical Flat (b) Optical Pyrometer
(c) Optical profile projector (d) Tooth Span Micrometer.

(viii) LVDT is usually used for measuring
(a) temperature (b) pressure
(c) density (d) displacement.

(ix) Sine bar should be
(a) used for measurement of an angle greater than 45°
(b) used for measurement of an angle less than 45°
(c) used for measurement of any angle
(d) none of these.

(x) Symbol "inverted triangle" is used in engineering drawings for representing
(a) shape of a component (b) surface Flatness
(c) hardness (d) surface roughness.

Group - B

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

(b) Explain with sketch how the following can be measured and by using which instruments for a lathe
(i) The machine is levelled with respect to horizontal plane
(ii) Radial runout of the headstock spindle
(iii) Parallelism of the headstock spindle with the guide ways.

(2 × 3) + (2 × 3) = 12

3. (a) Explain with a sketch how tooth thickness at pitch circle diameter is measured by using a Gear Tooth Calliper (No derivation required). Why is this measurement not very accurate?

(b) Explain with a sketch what does a tooth span micro meter measures. Name the design parameters of the gear on which this measured value depends.

(c) A 100mm sine bar is used to measure angle of a component. Slip gauges having total height of 25.882 mm is put under the sine bar roller to make the top surface of the component horizontal. Calculate the angle of the component.

(3 + 1) + (3 + 1) + 4 = 12

Group - C

4. (a) Briefly explain with sketch how a Profile Projector works.

(b) How a Profile projector can be used for measuring pitch and thread angle of a screw?

(c) Explain with sketch how pneumatic gauges are used for measuring (i) outside dia of a shaft and (ii) bore taper of a ball bearing inner race.

4 + 4 + (2 + 2) = 12

5. (a) (i) Explain "maximum metal limit" (MML) and "least metal limit" (LML) condition for hole shaft assembly with example.
(ii) What is "Fit"? What are the different types of fit?

(b) Calculate the limits of tolerance and allowance for 25 mm shaft and hole pair designated H_8d_9 type of fit. Size 25 mm falls in the diameter step 18 and 30 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.

(3 + 3) + 6 = 12

Group - D

6. (a) Explain graphically 3 cases when the conditions are:
(i) precise but not accurate
(ii) accurate but not precise
(iii) accurate and precise

(b) (i) What is the difference between followings (any one)
- active and passive transducer
- repeatability and reproducibility.

(ii) Write down the calibration method of a vernier caliper.

(1 + 1 + 1) + (4 + 5) = 12

7. (a) With neat sketch of an actual "surface texture" indicate the parameters (i) lay, (ii) waviness, (iii) roughness (vi) sampling length.

(b) In the measurement of surface roughness heights of 25 successive peaks and troughs were measured from the centre line and were 32, 26, 37, 35, 42, 22, 35, 18, 42, 28, 35, 22, 37, 18, 42, 22, 32, 21, 37, 18, 35, 22, 32, 18 and 34. If the sampling length is 25 mm determine C.L.A. and R.M.S. value.

(1 + 1 + 1 + 1) + (4 + 4) = 12

Group - E

8. (a) A Strain Gauge Load Cell has a single strain gauge mounted on the surface of a cylindrical rod along the axis of the rod. The strain gauge is connected to one of the arms of a Wheatstone bridge. The magnitudes of the resistance of the strain gauge and other resistances in the other three arms of the bridge are same such that the bridge is balanced (output voltage is zero) when strain in the strain gauge is zero.

Given: Input voltage to the Wheatstone Bridge : ei
Gauge Factor of the Strain Gauge : $F = \Delta R / (\epsilon.R)$
Cross-section area of the rod : A
Young's modulus of the rod material : Y

Develop the relationship between the axial strain on the rod and the voltage developed in the bridge.

(b) Develop the relationship between the axial compressive force F_C applied on the rod and the voltage developed in the bridge.

9 + 3 = 12

9. (a) Explain with neat sketch how a LVDT indicates the magnitude and direction of displacement.

(b) Explain the working principal of a bourdon tube gauge with neat sketch. What are the parameters we consider to choose tube material? Give two examples of tube material.

5 + (4 + 2 + 1) = 12

METROLOGY AND 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 any 5 (five) from Group B to E, taking at least one 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) The ratio of the infinitesimal change in output to the infinitesimal change in input is defined as
(a) sensitivity (b) resolution
(c) threshold (d) accuracy.

(ii) For measuring comparatively larger internal diameter (for e.g. 150mm) which instrument is suitable?
(a) Telescopic gauge (b) Inside tubular micrometer
(c) Vernier calliper (d) Vernier height gauge.

(iii) A Pitot tube is used for measuring
(a) diameter of a tube
(b) pressure of fluid flowing through the tube
(c) flow rate of fluid flowing through the tube
(d) density of the fluid flowing through the tube.

(iv) If the Fit between a shaft and hole is designated as N7/m6, assembly will have
(a) interference fit (b) transition fit
(c) clearance fit (d) cannot be ascertained.

(v) "Waviness" is
(a) primary texture (b) secondary texture
(c) flaws (d) tertiary texture.

(vi) A surface finish of 0.1 micron Ra can be easily achieved by
(a) milling (b) turning (c) grinding (d) shaping.