

**Mechanical Engineering Department**  
**Motilal Nehru National Institute of Technology Allahabad**  
**End Semester Examination (Even semester 2015-2016)**  
**B. Tech. IV Semester (Mechanical Engineering + Production and Industrial Engineering)**  
**ME-I403: Measurement and Metrology**

**Time: 3 Hours**

**MM: 100**

**Note: Attempt any five questions. Question no. 1 is compulsory. Make suitable assumption if needed.**

1. (A) For the differential arrangement of capacitive transducer, prove the output of it varies linearly with the displacement of movable plate. 5
- (B) Differentiate between: 15
  - a) Wire wound and Non-wire potentiometers
  - b) Thermocouple and Bimetallic thermometer
  - c) Line and End Standards
  - d) Tolerance and Allowance
  - e) Hole basis and Shaft basis systems of fit
- (C) Explain the principle and working of following instruments with figure 20
  - a) LVDT
  - b) Barometer
  - c) Knudsen Gauge
  - d) Spring Balance
  - e) Hydraulic load cell
2. (A) Explain the principle and working of total radiation pyrometer with figure. 5
- (B) What are the desirable properties of manometric fluids? Write name of four manometric fluids. 5
- (C) What is interchangeable assembly? Explain with example. 5
3. (A) A manometer has a well of 20 mm in diameter and a tube of 4 mm of inner bore. It is proposed to use a scale graduated accurately in mm to measure the pressure directly i.e. 1 mm scale division indicates a 1 mm pressure head change. Calculate the angle at which the tube must be inclined to vertical to do this. Density of mercury is  $13.56 \times 10^3 \text{ kg/m}^3$ . Assume 1 mm Hg = 133 N/m<sup>2</sup>. 5
- (B) A strain gauge is bonded to a beam 0.1 m long and has a cross-sectional area 4 cm<sup>2</sup>. Young's modulus for steel is 207 GN/m<sup>2</sup>. The strain gauge has unstrained resistance of 240  $\Omega$  and a gauge factor of 2.2. When a load is applied, the resistance of gauge changes by 0.013  $\Omega$ . Calculate the change in the length of the steel beam and amount of force applied to it. 5
- (C) For a thermistor if the value of  $\beta$  is 4000 °K and the resistance of it is 200 k $\Omega$  at -100 °C find the value of resistance at 400 °C. Find the ratio of two resistance for platinum over the same temperature. Platinum has a resistance temperature co-efficient of 0.0039 /°C. 5
4. Define fits. Describe various types of fits with examples and sketches. 15
5. Find the limit sizes, tolerances and allowances for a 60 mm diameter hole and shaft pair designated by  $\phi 60 \text{ H7 g6}$ . Also specify the type of fit that the pair belongs to. Given 60 mm diameter lies in the diameter step range of 50-65 mm. Fundamental deviation of g shaft is  $-2.5 D^{0.34}$ . The values of standard tolerances for grades IT 6 and IT 7 are 10i and 16i respectively. Also, indicate the limits and tolerances on a diagram. 15

P.T.O.

6. Write short note on any five of the following:

- a) Piezoelectric transducer
- b) McLeod gauge
- c) Temperature compensation by use of dummy gauge
- d) Proving rings
- e) Pressure gauge thermometer
- f) Taylor's principle of gauge design
- g) Sine bar