

2013 ME3112 Metrology And Instrumentation – Test 1

Max. Marks: 20

Approved tables are permitted

Time: 60 minutes

All questions carry 2 marks each unless otherwise mentioned

1. Define the terms Precision, Trueness, Systematic error and Measuring Interval according to VIM 2008. The mass of a weight in a commercial weight box was compared with a standard mass of 100 g several times and the obtained readings were: 100.33, 100.32, 100.31, and 100.32 g. Determine the bias and random error for the first reading.
(3 marks)
2. What are the two major proposals for the redefinition of the kilogram?
3. The diameter of an aluminium shaft was measured using a stainless steel vernier at 30 °C and found to be 54.52 mm. Estimate the true diameter of the shaft if aluminium and stainless steel have a coefficient of expansion of 24 ppm and 12 ppm respectively.
4. Explain the concept of “concomitant methods” in measurement. Explain how this led to the discovery of argon.
(3 marks)
5. A thermometer has a time constant of 10 s and behaves as a first order system. It is initially at a temperature 40 °C and then suddenly subjected to a surrounding temperature of a 120 °C. Calculate the temperature indicated 5 s after the process has been initiated.
6. Draw the characteristic curves of frequency response and phase response of a second order system to a harmonic input.
7. A 100 Ω resistance strain gauge with gauge factor 2.0 is subject to a strain of 50 $\mu\text{m}/\text{m}$. Determine the corresponding change in resistance.
8. Sketch and describe an arrangement to measure principal strains in a shaft subject to torsion.
9. Discuss how temperature changes affect strain measurement using strain gauges.

SOLUTION TO NUMERICAL PROBLEMS:

3.

$$L_{20} = L_T + (20 - T)\alpha L_T$$

$$L_{20ver} = L_{Tver} + (20 - T)\alpha L_{Tver}$$

$$L_{20ver} = L_{Tver} [1 + (20 - T)\alpha]$$

$$L_{Tver} = \frac{L_{20ver}}{[1 + (20 - T)\alpha]}$$

$$L_{Tver} = \frac{54.52}{[1 + (20 - 30)12E - 6]}$$

$$L_{Tver} = 54.526543$$

$$L_{20sh} = L_{Tsh} + (20 - T)\alpha L_{Tsh}$$

$$L_{20sh} = 54.526543 + (20 - 30)24E - 6 * 54.526543$$

$$L_{20sh} = 54.513457$$

$$L_{20sh} - L_{20ver} = (20 - T)(\alpha_{sh} - \alpha_{ver})L_T$$

$$54.513458$$