

ME3112 Metrology And Instrumentation – Test 2 (2014 March)

Max. Marks: 20

Approved tables are permitted

Time: 60 minutes

All questions carry 2 marks each unless mentioned otherwise.

1. Explain the implication of central limit theorem for the uncertainty quantification?
2. The moment of inertia, I , of a solid cylinder of mass M , rotating about its principal axis, is given by

$$I = \frac{MR^2}{2}$$

where R is the radius of the cylinder. Six repeat measurements were made on the mass using an

electronic weighing balance with a resolution of 1 mg and five measurements were made to determine the radius of the cylinder using a vernier caliper of 0.02 mm resolution.

Mass /g	20.72	20.75	20.74	20.72	20.75	20.74
Radius/mm	4.46	4.44	4.46	4.48	4.47	

The mass and radius measurements were not correlated. Determine the best estimate of the moment of inertia and the expanded uncertainty with 95% level of confidence.

[6 marks]

3. A diesel engine cylinder bore diameter is specified as $210.2^{+0.055}_{-0.025}$ mm. Meeting the cylinder bore specification is essential for the accurate functioning of the piston assembly system. One such cylinder bore is measured and its diameter is found to be 210.233 with an expanded uncertainty of ± 0.008 mm. Can the cylinder bore acceptable with a guard band of (a) 50 % (b) 100 %? Justify.
4. A signal expected to be of the form $F(t) = 20 \sin 62.8t$ where t is in seconds is to be measured with an instrument of time constant 20 ms. Estimate the form of the steady state output signal if the initial output is zero and static sensitivity is 2.
5. Sketch the dynamic response of a second order instrument with damping ratio 0.25 subject to a step input..
6. An instrument having a resonance frequency of 2828 rad/s with a damping ratio of 0.25 is used to measure a signal of 250 Hz. Estimate the expected dynamic error and phase shift.
7. Design a snap gauge (sketch and dimension) to inspect a shaft of diameter $50^{+0.120}_{-0.250}$ mm. Use unilateral tolerances with wear allowances.
8. How is the length of a gauge block defined? What is the benefit?