PE255T 2008 Metrology and Computer Aided Inspection – Test 2

Max. Marks: 20 Time: 60 minutes

All questions carry 2 marks each.

1. The area of a rectangle is calculated from measurements of length (6 readings) and breadth(5 readings). The uncertainty budget (incomplete) is given below. Determine the expanded uncertainty for Area (95%).

Quantity	Value	Std Unc	dof	Sensitivity	Contribution
Length	60mm	0.2	?	40	8
Breadth	40mm	0.1	?	60	6
Area	2400mm^2	10	?		

2. The diameter of a piston to be used in an aircraft engine had a specification of 50-0.012/-0.028mm. A piston manufactured in the machine shop was inspected and found to have a diameter 49.9865+/-0.002(95%). Is the piston acceptable, if a guard band of 50% is used?

3. A thermocouple with a time constant of 2s and currently at 30^{o}C is suddenly dipped into a bath of 80^{o}C. What will be the temperature shown by the thermocouple after 3s?

4. What do you mean by magnitude ratio? Sketch its variation with frequency of input signal for various values of damping.

5. Sketch the 2 bit image represented by the matrix $\begin{bmatrix} 0 & 1 & 2 & 3 \\ 1 & 1 & 2 & 3 \\ 2 & 2 & 2 & 3 \\ 3 & 3 & 3 & 3 \end{bmatrix}$ using different types of shading.

6. What is structured lighting? Give one of its applications.

7. Describe any method of smoothing noisy images.

8. What is parallax error? How can it be minimised?

9. An operator measured ten components twice in random order with results as given in table below. Comment on the discriminating power of the instrument. (Need not plot charts).

Part	1	2	3	4	5	6	7	8	9	10
Reading 1	6.4	5.4	4.8	6.2	5.9	4.6	5.3	5.7	5.4	6.0
Reading 2	6.5	5.6	4.8	5.9	5.8	4.6	5.2	5.8	5.2	6.1

10. Explain the meaning of reproducibility. Estimate its value, if an R&R study was carried out by three observers measuring 10 components twice and their grand averages were 10.12, 10.18 and 10.21.

SOLUTIONS TO NUMERICAL PROBLEMS:

1.

dof = 8.747 rounded down to 8
t = 2.306
(2423.06, 2376.94) mm^2

2.

Aircraft engine, hence stringent inspection
USL = 49.988, LSL = 49.972, guard band = 0.001
Measurement = 49.9865, USL-gb = 49.987, LSL+gb = 49.973
Hence result is acceptable

3.

68.84349 ^oC

9.

xbarbar = 5.56, Rbar = 0.12
UCLR = 0.392, LCLR=0.0
Range in control

UCLxbar = 5.7856, LCLxbar = 5.3344

More than 50% points outside control limits, hence instrument is capable.

10.

R = 0.09
d2 = 1.693
σ (reproducibility) = 0.0532