PE255T Metrology and Computer Aided Inspection – Final Exam April 2008

Max. Marks: 50   Time: 180 minutes

All questions carry 2 marks each, unless otherwise mentioned.

1. Define the term "influence quantity". Give an example and explain.

2. A multimeter when used to measure a standard resistance of 10Ω gave the following readings: 10.46, 10.32, 10.21, 10.69, 10.64, 10.71, 10.8, 10.41, 10.67, 10.52Ω. Estimate the systematic error of the multimeter and the random error for the first reading.

3. The resistance of a copper coil is given by $R=R_0*[1+\alpha(T-T_0)+\beta(T-T_0)^2]$, where $R_0 = 100\Omega$, $T_0 = 30^oC$, $\alpha = 0.0043^oC^{-1}$ and $\beta = -0.000002^oC^{-2}$. Determine the sensitivity of resistance to temperature at 300^oC.

4. Explain the strategy of concomitant methods, with an example.

5. Differentiate between error and uncertainty.

6. The stress caused by a load P at a distance l from the fixed end of a cantilever beam is given by $\sigma = \dfrac{6Pl}{wt^2}$, where w is the width of the beam and t the thickness. The load P is (20 +/-1) N (95%). Distance l is 0.60m, measured with a scale of least count 0.01m and uncertainty uniformly distributed. The width w is 0.04m and thickness t is 0.01m, both with standard uncertainties of 0.001m. Determine the standard uncertainty in stress. Assume all uncertainties to be uncorrelated.

(4 marks)

7. The area of a rectangle is calculated from measurements of length (5 readings) and breadth (4 readings). The uncertainty budget (incomplete) is given below. Determine the expanded uncertainty for Area (95%).

Quantity	Value	Std Unc	dof	Sensitivity	Contribution
Length	30mm	0.1	?	20	2
Breadth	20mm	0.05	?	30	1.5
Area	600mm^2	2.5	?		

8. What do you mean by time constant? Explain its importance.

9. A displacement sensor initially showing 0 was given a sudden input displacement of 5mm. The sensor has a natural frequency of 10rad/s and damping ratio 0.2. Sketch qualitatively the displacement shown by the sensor during the period from 0 to 10radians.

10. One observer measured ten parts twice and the average of the ranges between the repeated measurements was $2.8\mu m$. Estimate the repeatability. Is the measurement system adequate to measure a component of dimension 30+/-0.05mm? Justify your answer.

11. What do you mean by segmentation, in Machine Vision? Describe any one method for the same.

12. What is the purpose of stylus qualification before CMM measurements?

13. How is the length of a gauge block defined? What is the benefit of this definition?

14. What is Abbe's principle? Does a CMM conform to this principle? Why or why not?

15. Explain how a back pressure based pneumatic transducer senses a linear dimension, with the help of a sketch showing the arrangement of orifices.

16. What is the difference between evaluation length and traverse length in surface roughness measurement?

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17. The heights of a surface profile from an arbitrary datum were obtained as: 1.55, 1.47, 0.85, 0.25, -0.54, 0.04, 2.72, 2.9, 1.91, 2.63, 1.78, -0.12, -1.07, 2.17, 2.28, 2.47, -0.41, 0.91, 0.7, 1.77(μm) in steps of 0.2mm along the x axis. Determine Rp, Rv and Rt for the profile. Assume that the surface is well aligned with the datum.

(4 marks)

18. A dial gauge has its point worn out to a flat of 2mm dia as shown in Figure 1 below left not to scale. During measurement, its spindle is misaligned to the surface being measured by an angle of 5°. If the observed reading of the dial is 3.24mm, estimate the correct reading. Make suitable assumptions.
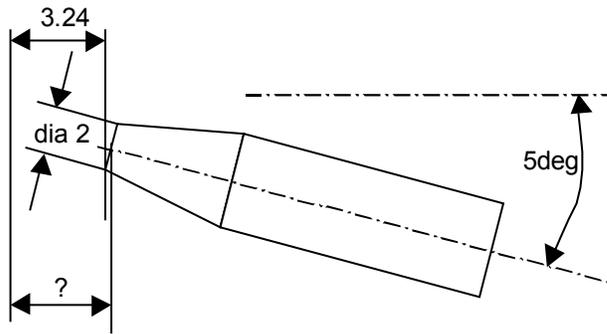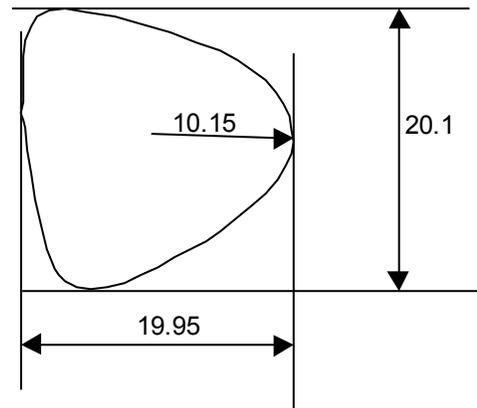

Figure 1   Figure 2

19. What is the principle of independency in drawings? If the diameter of a shaft is specified as 20+/-0.1mm and the cross-section of a shaft as shown in Figure 2 above right, is it acceptable? Why or why not?

20. An optical flat was placed over a gauge block and illuminated with a sodium vapour lamp of wavelength 0.6μm resulting in a fringe pattern as shown in Figure 3 below left. Determine the height / depth at the centre of the gauge block vis a vis the long edges.
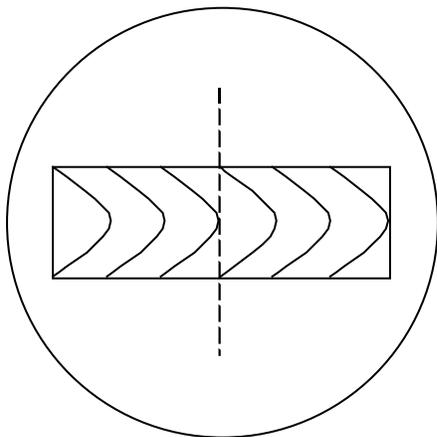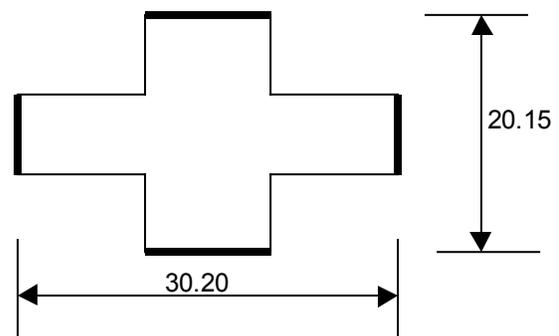

Figure 3   Figure 4

21. It is required to check a rectangular slot of specified length 30+/-0.20, width 20+/-0.15 and depth 10mm. A gauge designer has designed and fabricated a NO GO gauge of length 5mm and cross section as shown in Figure 4 above right, so that both length and width could be checked simultaneously. Comment on the suitability of this gauge to ensure conformity to specification.

22. Design a GO and NOGO plug gauge (determine dimensions and sketch) to check a hole of dia 40+0.12mm. Allow a unilateral gauge tolerance of 10% with a wear allowance equal to half the gauge tolerance.

(4 marks)

23. Give one good point about this course b) Give one suggestion which you think will best improve this course.