22/11/13

Roll No. | | | | | | | | | | |

B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, NOV / DEC 2013

MECHANICAL ENGINEERING

Semester 5

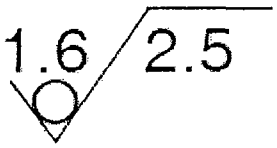
ME 9311 & Metrology and Measurements

(Regulation 2008)

Time : 3 Hours | Answer ALL Questions | Max. Marks 100

PART-A (10 x 2 = 20 Marks)

1. Why measuring instruments should be calibrated?
2. What is the difference between accuracy and uncertainty?
3. Calculate the radius of curvature of the inside surface of the glass tube of a spirit level which has a sensitivity of 1 second per division. Each division is 2.5 mm apart.
4. What are the applications of angle gauge blocks?
5. What are the advantages of using laser scanners in CMMs?
6. What is image processing?
7. What is meant by functional inspection of gears?
8. Interpret the symbol given below.



9. What is meant by reliability of a measurement?
10. What is the principle behind optical pyrometers?

Part – B (5 x 16 = 80 marks)

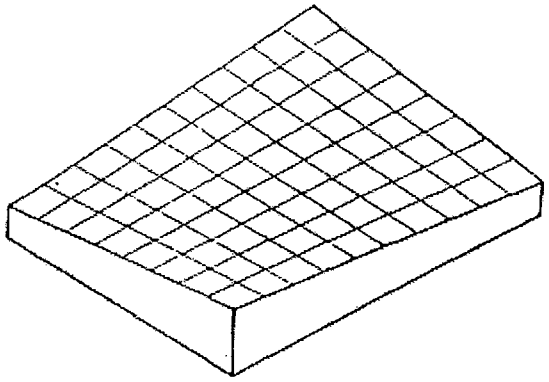
11. The temperature of the tube furnace is determined using a Type S (Pt10%Rh-Pt) thermocouple. The thermocouple was calibrated and a calibration report is available. The furnace is controlled to a temperature of 1000 °C (1832 °F) by an electronic controller. The thermal voltage generated by the thermocouple is measured using a digital voltmeter using a measuring location selector switch. The thermocouple has a reference junction temperature of 0 °C (32 °F). For the thermal voltage measurements a voltmeter with a resolution of 0.01 µV with a measuring range of 200 mV is used. The voltmeter was calibrated and a calibration report is available.

The total measurement uncertainty consists of the following measurement uncertainty components

1. The accuracy and stability of the reference junction temperature is estimated at 0 °C (32 °F) to be ± 0.1 K. The distribution function of the uncertainties has a uniform distribution.

2. The uncertainty, consisting of the non-homogeneities of the thermocouple is estimated (results from previous evaluations) to be ± 0.3 K (uniform distribution).
3. The measuring location selector switch produces parasitic thermal voltages (contact resistance), which cause errors in the measured value. From the data sheet for the instrument, maximum parasitic thermal voltage uncertainties of ± 3 μV are used. These correspond to a temperature uncertainty of ± 0.2 K.
4. The uncertainty of the calibration of the thermocouple is specified in the calibration report as ± 0.8 K. For this value, a confidence interval of k = 2 has been specified, which yields a probability of > 95 %.
5. The uncertainty in the calibration of the voltmeter is ± 3 μV (k = 2, normal distribution). From the data sheet it is known that at 1000°C, the emf of a type S thermocouple is 10mV. (i.e. 1μV uncertainty corresponds to temperature uncertainty of 0.1K).
6. The thermal voltage is measured 20 times at approximately 1 minute intervals. An average and the standard deviation of the measured values are calculated.
The resultant standard deviation is ± 4 μV. This value is used as the standard uncertainty of the measurement value acquisition in determining the total measurement uncertainty.
Estimate the measurement uncertainty for the measurement of the "true" temperature in the furnace at a coverage factor of k = 2 (confidence interval = 95 %).

12. a) (i) Explain the construction and working principle of angle dekkor with a neat diagram. **(8)**
(ii) A surface is tested for flatness using an Autocollimator. Measurements are made along the generators shown in the fig. It is found that the deviation from straightness is zero for all the positions along the generators shown. Can it be inferred that the surface is flat? Justify your answer. **(8)**



OR

b) Design "general" type GO and NO GO gauges for a 45 H7/f8 fit. 45 mm lies in the diameter range 30 to 50. Show graphically the disposition of gauge tolerance zones relative to the work tolerance zones. The upper deviation for 'f' shaft is $-5.5D^{0.41}$. The tolerance grades IT 7 and IT 8 have values 16i and 25i respectively, where "i" is the standard tolerance unit in microns.

13. a) (i) What are the different types of CMM configurations (based on construction) available? Explain **any one** with a neat diagram. **(10)**
(ii) What are touch trigger probes? What are their advantages? **(6)**

OR

b) With a neat diagram explain the working principle of a heterodyne (two frequency) Laser interferometer. Show graphically how the laser source and interferometer arrangement for measuring pitch errors along the main horizontal axis (x – axis) of a horizontal machining center.

14. a) (i) What are the various components of a surface profile? Why is surface finish measured? **(8)**

(ii) With neat diagrams define how roundness error is measured in the Least square circle method and Minimum zone method. **(8)**

OR

b) Derive the expression for (i) chordal tooth thickness of a gear and (ii) tooth thickness in the constant chord method.

15. a) (i) Write a few applications of temperature measurement in mechanical industries. **(6)**

(ii) Explain the construction and working principle of **any one** instrument for measuring temperature. **(10)**

OR

b) What are the various errors which occur in measurements? What are the precautions to be taken to eliminate or minimise them?