

Name:.....

Roll No.:.....

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Department of Mechanical Engineering

End Semester Examination, April 2010

IV Semester B.Tech. – Production Engineering

MEV614 METROLOGY AND COMPUTER AIDED INSPECTION

Time: Three hours

Maximum Marks: 50

All questions carry 2 marks each, unless otherwise mentioned. Metrology Tables will be provided.

1. Define the terms "Measurement" and "Measurand" and differentiate between them.
2. Temperature is measured using a thermocouple and millivoltmeter. Identify the basic elements of this measurement system with justification.
3. What do you mean by Measurement Bias? Explain with an example.
4. Explain the concept of concomitant methods.
5. A temperature varies with a frequency of 10 Hz. What is the maximum inaccuracy if a thermometer of time constant 0.01 is used?
6. A voltmeter can be modelled as a second order measuring system with natural frequency 50 Hz. If a sudden voltage of 50 V is applied, sketch the variation in output for different damping ratios.
7. The acceleration due to gravity a at a distance d from the centre of the earth is given by the formula $a = \frac{r^2 g}{d^2}$, where r is the radius of the earth and g the acceleration due to gravity at the earth's surface.

The distance d was estimated seven times with readings 8190, 8330, 8280, 8210, 8240, 8350, and 8180 km. Assume that the readings are independent. The radius r was estimated as 6360 km with uncertainty triangularly distributed between +/-10 km. These two measurements are correlated with a correlation coefficient 0.6. The value of g is obtained from a handbook as 9.81 m/s², which also mentions that the error will not exceed 0.1 m/s² at all. Determine the 95% expanded uncertainty interval for the acceleration a . Neglect the effect of correlation on the degrees of freedom and tabulate the intermediate results neatly in the uncertainty budget format given below.

Quantity	Value	Std Unc	Dof	Sensitivity (optional*)	Contribution
d	?				
r	6360 km				
g	9.81 m/s ²				
Correlation d, r	0.6	-	-		
a					

*Not required in case numerical approach is used

(8 marks)

8. The diameter of a piston is specified as 37.9 –0.2 mm. Seven pistons were measured twice by a machinist in random order with results as below:

Part	1	2	3	4	5	6	7
Reading 1	37.98	37.87	37.82	37.92	37.93	37.86	37.91
Reading 2	37.95	37.85	37.85	37.95	37.94	37.86	37.89

Is it OK to use the measuring instrument for inspection during machining? Why?

PTO

9. Design a GO and NOGO plug gauge (determine dimensions and sketch) to check a hole of dia 40 +0.12 mm. Allow a unilateral gauge tolerance of 10% with a wear allowance equal to half the gauge tolerance.
10. Explain what is parallax error. How can it be reduced?
11. An M88/2 gauge block set has sizes 1No of 1.005, 9 Nos of 2.001 to 2.009 in steps of 0.001, 49 Nos of 2.01 to 2.49 in steps of 0.01, 19 Nos of 0.5 to 9.5 in steps of 0.5, 10 Nos of 10 to 100 in steps of 10, and 2 wear blocks of 2 mm. Select slip gauges to combine to a size of 41.871 mm.
12. Explain how the value of cut-off chosen affects the results of Ra obtained.
13. The heights of a surface profile from an arbitrary datum were obtained as: 1.16, -0.47, -1.23, -1.23, -0.4, -1.36, -1.29, 0.59, -0.41, -1.42, 0.41, -0.71, 1.26, -1.16, -1.26, 1.33, -1.28, 0.62, -0.67, 0.98 (μm) in steps of 0.1mm along the x axis. Determine Rsm for the profile. Assume that the surface is well aligned with the datum. (4 marks)
14. Define and differentiate between "Datum" and "Datum feature"
15. Sketch the symbol for the geometrical tolerance "Profile of a surface" and explain how it is defined.
16. Sketch four common configurations of a CMM marking their salient features.
17. What is the difference between a "Touch Trigger probe" and "Scanning probe" used in a CMM?
18. Explain what is "structured lighting". How can it be used to measure the thickness of a plate?
19. Use histogram segmentation to identify the letter in the image represented by the matrix

7	6	6	5	5	5
7	6	1	1	0	4
7	2	5	5	5	4
7	2	5	5	5	4
7	6	1	1	0	4
7	6	6	5	5	5

 (4 marks)
20. Sketch the object represented by the eight directional chain code 00134466.
21. Describe any one method of object description in Machine Vision.
22. Give a) one good point about this course b) Give one suggestion which you think will best improve this course.

SOLUTIONS TO NUMERICALS

5.
 f 10 Hz
 Tau 0.01

 Omega 62.83185
 Tau 0.628319
 Omega
 M 0.846733
 15.3267 %

7.
 Value Std Unc Dof
 d 8254.286 25.52843 6
 r 6360 4.082483
 g 9.81 0.057735
 a 5.824039

d+	d-	r+	r-	g+	g-	
8279.814	8228.757285	8254.286	8254.286	8254.286	8254.286	
6360	6360	6364.082	6355.918	6360	6360	
9.81	9.81	9.81	9.81	9.867735	9.752265	
5.78818	5.860230973	5.831518	5.816564	5.858315	5.789762	r 0.6
ud(a)	-0.036025261	u(r)a	0.007477	u(g)a	0.034276	-0.00032
uc	0.046961		ud(a)^4	1.68434E-06		
	4.86E-06			2.80723E-07		
dof	17.32539					
	17					
t	2.11	2.109819				
U	0.099088	U+	5.923127	U-		5.72495

8.
 Part Reading 1 Reading 2 xbar R
 1 37.98 37.95 37.965 0.03
 2 37.87 37.85 37.86 0.02
 3 37.82 37.85 37.835 0.03
 4 37.92 37.95 37.935 0.03
 5 37.93 37.94 37.935 0.01
 6 37.86 37.86 37.86 0
 7 37.91 37.89 37.9 0.02
 37.89857 0.02

USL 37.9
 LSL 37.7
 T 0.2
 d2 1.128
 P 0.01773

11.
 2.001
 2.37
 7.5

30
41.871

13.

19.

Value	frequency
0	2
1	4
2	2
3	0
4	4
5	12
6	6
7	6

