2006 MEC603 ADVANCED METROLOGY AND COMPUTER AIDED INSPECTION FINALTEST

Max. Marks: 33+17=50 **Time: 3 Hours**

Use separate answer sheets for Part A and B

Part A

1. The temperature in a room was measured at five places with the results 30.1, 31.2, 30.8, 30.4, 32.1. Determine a 95% expanded uncertainty for the room temperature.

(2 marks)

2. A test specimen of cross-section 10x5mm was pulled in a UTM and the ultimate load was 1450N. The length and breadth of the specimen was measured with the same digital vernier and hence is expected to have a correlation of 0.6. The digital vernier had a least count 0.1mm with other sources of uncertainty being negligible. The manufacturer of the UTM gives an uncertainty of +/-20N with 99% confidence. Estimate the standard uncertainty in tensile strength of the material.

(6 marks)

3. The inner diameter of a washer used in a non-critical application is specified as 20+0.10mm. A sample washer measured (20.108+/-0.01)mm. Is the washer acceptable? Consider guard bands of 100% and 50%, and explain your result.

(2 marks)

4. Calculate the Euclidean distance, City Block distance and Chessboard distance between pixels (1,1) and (5,4)

(2 marks)

5. Explain the gradient based approach for edge detection.

(2 marks)

6. Make a histogram of the 3 bit image matrix given below and using thresholding, segment into a binary image.

0	1	2	1	2
1	5	6	7	3
2	6	7	6	2
1	7	6	5	1
2	3	2	1	2

(3 marks)

7. What do you mean by signature? Sketch the centroidal distance based signature of a square object.

(2 marks)

8. What are some of the texture descriptors used in machine vision? Explain.

(2 marks)

9. Describe any one method of pattern recognition.

(2 marks)

10. Explain Taylor's principle for limit gauges.

(2 marks)

11. The results of a straightness measurement are given as (0,3), (100,7), (200,4), (300,2), (400,5) where the first number is the distance along x axis in mm and the second number deviation from a horizontal reference line in microns. Determine straightness error based on the end-point reference line.

(3 marks)

12. Explain how the cut-off wavelength is selected for periodic surfaces.

(2 marks)

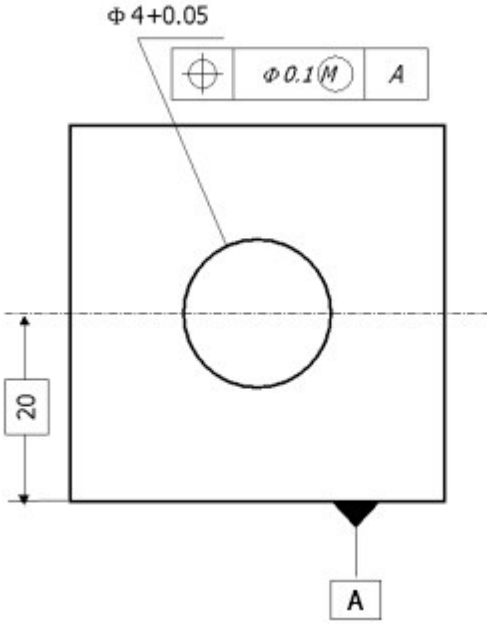
13. What is the role of autocorrelation function in surface roughness evaluation? Determine the the lag 2 autocorrelation for the series: 7, 5, 3, 1, 2.

(3 marks)

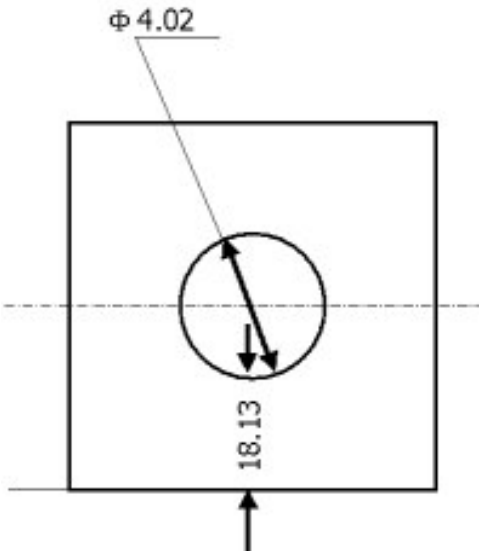
14. What are the issues in deciding workpiece orientation for CMM measurement?

(2 marks)

15. The drawing of a component is given below. If the diameter and centre distance of the hole in a manufactured component was measured and found to be as below, is the component acceptable? Explain why or why not.



Drawing



Measurement

(2 marks)

Solution to numericals:

1.

Average	30.92	dof	4	u	0.34843		31.8886
Stdev	0.7791	t(.95,4)	2.78	U	0.96862		29.9514

2.

		u	P+	P-	l+	l-	b+	b-	l,r
P	1450	7.75194	1457.75	1442.25	1450	1450	1450	1450	
l	10	0.02887	10	10	10.0289	9.97113	10	10	
b	5	0.02887	5	5	5	5	5.02887	4.97113	
S	29		29.155	28.845	28.9165	29.084	28.8335	29.1684	0.6
uc(S)	0.2755		0.15504		-0.0837		-0.1674		0.01682

		cP	0.02	cl	-2.9	cb	-5.8		
uc(S)	0.2755	uP(S)	0.15504	ul(S)	-0.0837	ub(S)	-0.1674	ulb(S)	0.01682

3. Non-critical, hence stringent rejection. 100% Acceptable, 50% Not acceptable

4. Euclidean=5, City Block=7, Chess=4

6.

Intensity	freq
0	1
1	6
2	7
3	2
4	0
5	2
6	4
7	2

0	0	0	0	0
0	1	1	1	0
0	1	1	1	0
0	1	1	1	0
0	0	0	0	0

11.

x	y	yest	e
0	3	3	0
100	7	3.5	3.5
200	4	4	0
300	2	4.5	-2.5
400	5	5	0
y=3+x/200		emax	3.5
		emin	-2.5
		sterror	6

13.

x	x2	x-xbar	x2-x2bar	prod
7	3	2	1	2
5	1	0	-1	0
3	2	-2	0	0
5	2	8	2	2
Autocorre	0.5			0.5

15. Measured distance to centre = 18.13 + 2.01 = 20.14
Allowable distance to centre = 20.00 +/-0.1 +/-0.02 = 19.88 to 20.12
Hence not acceptable.