

**ME6315 Advanced Metrology and Computer Aided Inspection**

TEST 1:

Max. Marks: 20

Time: 1 Hour

**Answer all questions. Supplement your answers with simple sketches, graphs, examples, etc.**  
Use separate answer sheets for Part A and B

**Part A**

1. Explain briefly the common sources of uncertainty in dimensional measurement. [2 marks]
2. The diameter of a cylinder was measured at five places using a digital vernier of least count 0.01mm and the following readings were obtained: 24.91, 24.79, 25.09, 24.93 and 25.13mm. The height of the cylinder was measured using a scale as 100.2mm with no variation in repeated readings. The manufacturer gives its uncertainty as +/-0.1mm triangularly distributed. The diameter and height measurements are expected to be correlated with coefficient 0.8. The mass of the cylinder was determined as 0.383 kg using a digital balance of uncertainty +/-0.008kg (95%). Determine the expanded uncertainty in the density of the material. [8 marks]
3. A company produces washers for a non-critical application. The ID of the washer is specified as 26+0.2mm. A sample washer taken for inspection had an ID of (26.23+/-0.04). Is the washer acceptable if the guard band is a) 100% b) 50%. [2 marks]

**SOLUTION TO PROBLEMS:**

2. The uncertainty due to least count in digital vernier =  $0.005/\sqrt{3}=0.002887$   
 Standard uncertainty due to repeated readings =  $0.139284/\sqrt{5}=0.06229$   
 Since the standard uncertainty due to least count is very small compared to that of repeated readings, it may be neglected. Otherwise, both may be combined as follows:  
 Standard uncertainty in dia =  $\sqrt{(0.002887^2 + 0.06229^2)} = 0.062357$ . It may be seen that the difference is very small.

	24.91	24.79	25.09	24.93	25.13	0.139284	0.06229	0.002887	
			d+	d-	h+	h-	m+	m-	
<b>d</b>	24.97	0.062357	25.03236	24.90764	24.97	24.97	24.97	24.97	
<b>h</b>	100.2	0.040825	100.2	100.2	100.2408	100.1592	100.2	100.2	
<b>m</b>	0.383	0.004082	0.383	0.383	0.383	0.383	0.387082	0.378918	
<b>p</b>	7805.560358		7766.721	7844.692	7802.381	7808.742	7888.744	7722.376	
			-38.83943	39.1315	-3.178951	3.181542	83.18389	-83.18389	
<b>u</b>			38.98546		3.180247		83.18389		14.08451
<b>uc</b>			92.99416						
<b>c</b>			625.2029		77.89982		20380.05		
<b>dof</b>	129.5006208								
<b>Uc</b>		185.9883							

3. Since the washers are non-critical, we may use relaxed acceptance. With 100% guard band, the effective USL becomes  $26+0.2+0.04=26.24$ . Since the measurement result is below the effective USL, it may be accepted. With 50% guard band, the effective USL becomes  $26+0.2+(0.50*0.04)=26.22$ . Now the measurement result is above the USL, hence reject the part.