METROLOGY AND INSTRUMENTATION

Time: 60 minutes
Marks: 8X5=40

Tables of the t distribution and Formulae for Uncertainties in Regression and Calibration may be used.

1. The mass of an object is measured in a balance and the following readings are obtained: 75.36, 73.38, 76.35, 75.26, 75.72, 75.94, 75.37 and 73.49g. Determine the Type A expanded uncertainty with 95% confidence, on the mass of the object.

2. A Titanium alloy was subjected to a tensile test with results as follows for stresses below the yield stress:

Stress MPa	117.7	229.7	344.6	456.6	568.6
Strain	0.001	0.002	0.003	0.004	0.005

   Determine the 95% expanded uncertainty in the Modulus of Elasticity. Assume that the strain values have negligible uncertainty.

3. The sample standard deviation of a time-dependent electrical signal, based on 20 measurements, is estimated to be 3.04V. How many more measurements would be required to provide an expanded uncertainty interval of +/-0.84V with 95% confidence?

4. The temperature in a room is measured as 20.1^{o}C with a Type A standard uncertainty of 0.2^{o}C. The digital thermometer used has a least count of 0.1^{o}C. Determine the Type B standard uncertainty due to the instrument resolution. Also determine the combined standard uncertainty.

5. The mass of a spherical object was determined to be 775+/-1.2g(95%), while its diameter was measured as 57.8+/-0.8mm(95%). Determine the density of the object from the mass and diameter measurements and calculate its expanded uncertainty.

6. A vibration with a frequency of 50kHz was digitally sampled at a frequency of 80kHz. Determine the frequency of the vibration that will be obtained after Fourier Transformation of the sampled data. If the frequency resolution was 0.2kHz, what was the time period over which sampling was carried out?

7. A successive approximation A/D converter has a full scale output of 0-8V and uses a six bit register. Estimate the final register value if an input of 5.9V is applied. What will be the time required per conversion if a 500kHz clock is used, and one approximation step is carried out per clock tick?

8. Explain the purpose of Signal Conditioning in a Digital Data Acquisition System.

ANSWERS

1.

75.10875	1.093388	2.306006	74.21731	76.00019

2.

xbar	3		
ybar	343.44		
n	5		
CSxx	10		
CSxy	1128.7	LCL	UCL
Beta1	112.87	111.9471	113.7929
Beta0	4.83	1.769053	7.890947

3.

3.04	20	2.093025	0.84	7.574756	57.37693	37.37693

4.

5.

775	1.2					
57.8	0.8					
density	0.007665131					
	7.665130707					
cm	9.89049E-06	1.18686E-05				
cd	0.000397844	0.000318275				
		0.000318497				
		0.318496538				

By perturbation,

Mass	775	776.2	773.8	775	775
Dia	57.8	57.8	57.8	58.6	57
Density	7.665131	7.676999	7.653262	7.355467	7.992424
		0.011869	-0.01187	-0.30966	0.327293
		0.011869	0.011869	0.309664	0.327293
		0.011869		0.318479	
		0.3187			

6. 30Hz, 0.005s

7.

1.25E-01	4.72E+01	101111		47	48	0.000012
				5.88E+00	6.00E+00	