MEV214 Metrology and Computer Aided Inspection – Test 2, Mar2009

Max. Marks: 20 Time: 60 minutes

All questions carry 2 marks each, unless mentioned otherwise.

1. The torque applied to a brake drum through a rope is given by T = (F_1 - F_2) r, where F_1 and F_2 are the forces on the two ends of the rope, and r is the radius of the pulley. The radius measurement is uniformly distributed between +/-0.01m. The uncertainty budget (incomplete) is given below. The two forces are correlated by 0.5. Determine the expanded uncertainty for torque (90%) neglecting the effect of correlation on the degrees of freedom.

Quantity	Value	Std Unc	No of readings	dof	Sensitivity	Contribution
F_1	100 N	1.5 N	8			
F_2	50 N	1 N	6			
r	0.25 m					
T	12.5 Nm					

(8 marks)

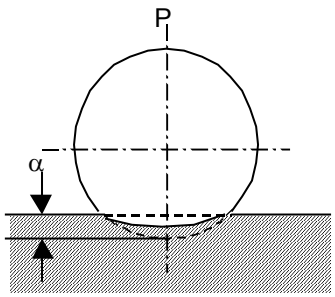
2. Explain the effect of resolution of a measuring instrument on the uncertainty.

3. A thermocouple of time constant 2s is used to sense a temperature alternating between 40 and 50 ^{o}C with a frequency 5rad/s. Graph the temperature shown by the thermocouple for a period of 10s.

4. A DC voltage was given to a voltmeter and it was showing a reading of 10V. Additionally, another voltage of 2V was suddenly provided. The voltmeter has a natural frequency of 5rad/s and damping ratio 3.0. Sketch the voltage shown by the voltmeter during the period from 0 to 20radians after the additional voltage was applied.

5. State and explain Taylor's principles of Limit Gauging.

6. A micrometer has 5mm dia faces and a ratchet mechanism to apply a force of 50N. When an aluminium cylinder 25mm long was measured using this micrometer, a diameter of 32.165 mm was obtained. Estimate the correct diameter of the cylinder.

Cylinder in contact with a plane		$\alpha = \left[\ln\left\{ \frac{8a^2}{(V_1+V_2)\bar{P}D} \right\} + 1 \right] (V_1+V_2)\bar{P}$
α = the total elastic compression at the point or line of contact of two bodies, measured along the line of the applied force, mm; P = total applied force, N; 2a = length of contact, mm; $\bar{P} = P/2a$; D = diameter of body, mm; V = 3.96498E-06 mm^2/N for Aluminium and 1.38829E-06 mm^2/N for Steel		

(4 marks)

7. Explain the mechanism why gauge blocks wring together.

SOLUTIONS TO NUMERICALS:

1.

Quantity	Value	Std Unc	No of readings	dof	Sensitivity	Contribution		
F1	100	1.5	8	7	0.25	0.375		
F2	50	1	6	5	-0.25	-0.25		
r	0.25	0.005774			50	0.288675		
F1, F2 correl				r=	0.5	-0.09375		
T	12.5				uc	0.438986	Nm	
Quantity	Value	Std Unc	F1+	F1-	F2+	F2-	r+	r-
F1	100	1.5	101.5	98.5	100	100	100	100
F2	50	1	50	50	51	49	50	50
r	0.25	0.005774	0.25	0.25	0.25	0.25	0.255774	0.244226
T	12.5		12.875	12.125	12.25	12.75	12.78868	12.21132
				0.375		-0.25		0.288675
			uc	0.438986	Nm			
uc^4	0.0371365							
	0.0197753	0.002825						
	0.0039062	0.000781						
dof	10.297657							
Round down	10							
t	1.81	1.812462						
U	0.7945638 Nm							

6.

P	50
a	2.5
D	5
Pbar	10
V1	3.96498E-06
V2	1.39E-06
V1+V2	5.35E-06
Alpha	7.03E-04
Obs dia	32.165
True dia	32.16641