PE255T 2008 Metrology and Computer Aided Inspection – Test 1

Max. Marks: 20 Time: 50 minutes

1. What are the various elements of a measurement system? Identify these elements for a Bourden tube type pressure gauge.

   (2 marks)
2. A standard resistance of 100ohms was measured using two different multimeters A & B with the following results: A) 101, 102, 98, 99, 104, 103, 95, 103, 95, 97 and B) 100, 102, 101, 99, 102, 103, 100, 99, 104, 100. Which multimeter is more accurate? Which is more precise? Justify your answer.

   (2 marks)
3. Define a) influence quantity b) metrological traceability.

   (2 marks)
4. Explain the evolution in the definition of the "metre".

   (2 marks)
5. The temperature inside a room was measured at six different places as 28, 31, 30, 29, 28, 30. Determine a 95% expanded uncertainty interval for the temperature.

   (2 marks)
6. The resistance of two coils was measured using a multimeter and the results obtained as 100Ω and 50Ω with standard uncertainties 1Ω and 0.5Ω respectively. Determine the overall resistance and its standard uncertainty if these resistances are connected in parallel.

   (5 marks)
7. The width of a wooden table was measured as 47cm using a metre scale with least count 1cm and a uniformly distributed uncertainty between divisions. The scale during calibration had shown a zero error +1cm with expanded uncertainty +/-0.5cm (95%). The two uncertainties are estimated to have a correlation of 0.8. Estimate the width of the table and its standard uncertainty. Neglect other sources of uncertainty.

   (5 marks)

SOLUTIONS TO MUMERICAL PROBLEMS:

2.

	A	B
	101	100
	102	102
	98	101
	99	99
	104	102
	103	103
	95	100
	103	99
	95	104
	97	100
Average	99.7	101
Range	9	5
Stdev	3.368151	1.699673

A is more accurate while B is more precise

5.

	28
	31
	30
	29
	28
	30
average	29.33333
stdev	1.21106
u	0.494413
t	2.57
U+	30.60398
U-	28.06269

6.

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{100 * 50}{100 + 50} = 33.33$$

$$c_{R_1} = \frac{R_2}{R_1 + R_2} - \frac{R_1 R_2}{\left(R_1 + R_2\right)^2} = \frac{50}{100 + 50} - \frac{100 * 50}{\left(100 + 50\right)^2} = 0.1111$$

$$c_{R_2} = \frac{R_1}{R_1 + R_2} - \frac{R_1 R_2}{\left(R_1 + R_2\right)^2} = \frac{100}{100 + 50} - \frac{100 * 50}{\left(100 + 50\right)^2} = 0.2222$$

Quantity	Result	Std Uncertainty	sensitivity	Contrib
R1	100	1	0.111111	0.111111
R2	50	0.5	0.444444	0.222222
R	33.33333	0.248456		

Numerical approach:

Quantity	Result	Std Uncertainty	R1+	R1-	R2+	R2-
R1	100	1	101	99	100	100
R2	50	0.5	50	50	50.5	49.5
R	33.33333		33.44371	33.22148	33.55482	33.11037
			0.111116		0.222225	
			0.061731			
			0.248456			

7.

L = M – E = 47 – 1 =46cm

$u(M) = \frac{0.5}{\sqrt{3}} = 0.288675$; $u(E) = \frac{0.5}{1.96} = 0.25510$;

$c_M = 1$; $c_E = -1$

$u_c = \sqrt{0.288675^2 + (-0.25510)^2 - 0.11783} = 0.174882$

Numerical approach:

Quantity	Result	Std Uncertainty	M+	M-	E+	E-	
M	47	0.288675	47.28868	46.71132	47	47	
E	1	0.255102	1	1	1.255102	0.744898	
L	46		46.28868	45.71132	45.7449	46.2551	
			0.288675		-0.2551		-0.11783
		0.030584					
		0.174882					