MEV214 Metrology and Computer Aided Inspection – Test 1, Jan 2010

Max. Marks: 20 Time: 50 minutes

All questions carry 2 marks each unless mentioned otherwise.

1. Define the terms “Sensor” and “Transducer” according to VIM, and differentiate.
2. A multimeter was used to measure a standard resistance of 10.15 ohms and five readings obtained were 10.30, 10.32, 10.31, 10.28 and 10.29. Estimate the trueness of the multimeter. State the major assumption made.
3. Explain what do you mean by “deadband”.
4. The best fit calibration equation of a pressure gauge of range 0-5 bar when loaded in the increasing direction is $y = 1.2 + 0.95 x$ and $y = 1.4 + 0.90 x$ when loaded in the decreasing direction. Estimate the sensitivity error, and hysteresis error at the middle of the range as a percentage of the FSO.
5. Define the metre in the SI system.
6. Explain the concept of concomitant methods with an example.
7. A thermocouple of time constant 0.2 s is used to measure a sinusoidally varying temperature of amplitude 50 ^{o}C and frequency 1 Hz. Estimate the amplitude of the temperature shown by the thermometer.
8. Plot a graph showing the response (Magnitude ratio and phase lag) of a second order measuring instrument with damping ratio 0.2 to sinusoidal signals of different frequencies.
9. The diameter of a wire was measured at several places with the values: 0.501, 0.502, 0.489, 0.501, 0.495, 0.499, 0.502. Determine a 99% expanded uncertainty interval for the mean diameter.
10. A tachometer was calibrated using a stroboscope and the results are given below. Determine the least squares calibration equation and the standard uncertainty of the slope.

Stroboscope reading	200	400	600	800	1000	1200
Tachometer reading	203	395	608	794	1010	1194

(4 marks)

SOLUTIONS TO NUMERICAL PROBLEMS:

3.

$R=100[1+0.004(T-20)+0.00002(T-20)^2]$

$dR/dT = 0.4 + 0.004(T-20)$

When T= 40, $dR/dT = 0.48\ \Omega/^{o}C$

4.

FS	5
eh	0.2
%eh	4

7.

xbar	250
s	12
n	50
U	1.697056
245.6216	254.3784

8.

x	y	ycap	e
0	-9.92	-10.6355	0.7155
6	-5.94	-4.611	-1.329
12	1.81	1.4135	0.3965
18	7.59	7.438	0.152
12	1.62	1.4135	0.2065
0	-9.86	-10.6355	0.7755
18	7.73	7.438	0.292
6	-5.82	-4.611	-1.209
-10.6355	1.004083	MSE	0.774914
Sigma xsq	1008		
Sigma x	72	xbar	9
CSxx	360		
se(Intcpt)	0.520788		

9.

$$I = \frac{P}{V} = 6.52A$$

$$c_P = \frac{1}{V} = \frac{1}{230} = 0.004348\,; \quad c_V = \frac{-P}{V^2} = \frac{-1500}{230^2} = -0.02836$$

cP	0.004348	50	0.217391
cV	-0.028355	5	-0.141777
			0.259537

Numerical approach:

		u	P+	P-	V+	V-
P	1500	50	1550	1450	1500	1500
V	230	5	230	230	235	225
I	6.521739		6.73913	6.304348	6.382979	6.666667
			uP	0.217391	uV	-0.14184
			uc	0.259574		