METROLOGY & INSTRUMENTATION – I Test

Time: 60 minutes Maximum marks: 50

Answer all questions. Explain the steps clearly, for problems. Answer only to the point.

1) a) Illustrate the difference between replication and repetition with the aid of an example.
b) Explain the importance of signal analysis of complex waveforms.
c) An input sinusoidal signal is given to a second order instrument. Sketch the magnitude and phase-shift of the response for various input frequencies. Assume that friction is negligible in the system.
d) Explain what is meant by a Design Stage Uncertainty analysis and how it is carried out.

(4X5=20 marks)

2) a) (i) A venturimeter is to be calibrated at 5 levels of pressure differences from 2 to 10 cm of mercury. Two operators are available to carry out the experiment. Prepare a test matrix showing the run order, randomizing the effect of pressure differences and operators. A total of 10 runs is to be carried out.

(5 marks)

(ii) The temperature inside a room varies between 15^{o}C at 3:00 hrs and 35^{o}C at 15:00 hrs of the day. Express the temperature as a function of time using a Fourier series. Explain the assumptions made.

(5 marks)

(iii) Explain the historical developments in the definition of the metre

(5 marks)

OR

b) The strain on an aircraft wing during flight is measured using a strain gauge. The values of strain during one fundamental cycle are as follows:

Time (s)	0.63	1.26	1.89	2.52	3.15	3.78	4.41	5.04	5.67	6.3
Strain X10^{-3}	8.25	8.95	8.95	8.23	5.96	2.31	-0.6	-0.5	2.46	6.08

Express the strain in the form of a Fourier series neglecting harmonics of order higher than two.

(15 marks)

3) a) (i) A speedometer was given a step input of 40kmph. If the instrument can be treated as a second order system with natural frequency 6.28Hz and damping ratio 0.6, predict the reading shown by the instrument after 1 second of application of the input.

(8 marks)

(ii) A displacement transducer gave the following results on calibration:

Displacement (mm)	5	10	15	20	25
Voltage (mV)	2.9	6.2	8.7	11.9	15.1

Determine the average static sensitivity of the instrument using the method of least squares.

(7 marks)

OR

b) (i) A thermometer is known to have a time constant of 20s. If it is now reading 20^{o}C and is dipped into water at 80^{o}C, determine the time it will take to read 75^{o}C.

(4 marks)

(ii) The sample standard deviation of a force, based on 5 measurements, is estimated to be 15N. How many more measurements would be required to provide a precision interval in the mean of +/- 10N?

(4 marks)

(iii) The mass of a bottle of medicine was measured and found to be 126g. The medicine was emptied and the mass of the bottle was found to be 26g. A calibration of the balance showed that it was always reading 1g +/-0.1g(95%) high. The overall precision of the balance is known to be +/- 1% of the reading at 95% confidence. Estimate the mass of medicine in the bottle and its uncertainty.

(7 marks)