Assignment 1: Mechatronics System Design

a) Total 10 marks (2 marks each)
b) MATLAB/PYTHON/C or any other programming tool can be used for calculations.
c) Answer all questions
d) Provide associated equations wherever necessary

NB: f.s.d. = full scale deflection

1)

A thermocouple used between 0 and 500 °C has the following input–output characteristics:

Input T °C	0	100	200	300	500
Output E μV	0	5268	10 777	16 325	27 388

(a) Find the equation of the ideal straight line.
(b) Find the non-linearity at 100 °C and 300 °C in μV and as a percentage of f.s.d.

2)

The following results were obtained when a pressure transducer was tested in a laboratory under the following conditions:

I Ambient temperature 20 °C, supply voltage 10 V (standard)
II Ambient temperature 20 °C, supply voltage 12 V
III Ambient temperature 25 °C, supply voltage 10 V

Input (barg)	0	2	4	6	8	10
Output (mA)						
I	4	7.2	10.4	13.6	16.8	20
II	4	8.4	12.8	17.2	21.6	28
III	6	9.2	12.4	15.6	18.8	22

(a) Determine the values of K_M, K_I, a and K associated with the generalised model equation $O = (K + K_M I_M)I + a + K_I I_I$.
(b) Predict an output value when the input is 5 barg, $V_S = 12$ V and ambient temperature is 25 °C.

3)

A liquid level sensor has an input range of 0 to 15 cm. Use the calibration results given in the table to estimate the maximum hysteresis as a percentage of f.s.d.

Level h cm	0.0	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
Output volts h increasing	0.00	0.35	1.42	2.40	3.43	4.35	5.61	6.50	7.77	8.85	10.2
Output volts h decreasing	0.14	1.25	2.32	3.55	4.43	5.70	6.78	7.80	8.87	9.65	10.2

4) (two questions)

An analogue-to-digital converter has an input range of 0 to 5 V. Calculate the resolution error both as a voltage and as a percentage of f.s.d. if the output digital signal is:

(a) 8-bit binary
(b) 16-bit binary.

A level transducer has an output range of 0 to 10 V. For a 3 metre level, the output voltage for a falling level is 3.05 V and for a rising level 2.95 V. Find the hysteresis as a percentage of span.

5) With appropriate diagram and equations, explain the working of a gyroscope?