EC4.201/EC4.404: Mechatronics System Design: Assignment I (2025)

- *Total 10 marks (2+2+2+4).*
- *Answer all the questions.*
- *Due date: Feb 10, 2025.*
- *Assume any data if found missing and mention your assumption in the answer.*
- *MATLAB, PYTHON programming can be used (no need to submit the codes).*

Q.1) Give the details of static and dynamic characteristics of any 2 MEMS accelerometer available in the market ?

Q.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.

Q.3) A force sensor has a mass of 0.5 Kg, stiffness of 200 N/m and a damping constant of 6.0 Ns/m. Calculate the following ?
a) Calculate the steady-state sensitivity, natural frequency and damping ratio for the sensor.
b) Calculate the displacement of the sensor as a function of time for a change in input force from 2 N to 3 N.
c) Find the value of damping constant for which the resonant frequency is 82 percent of the natural frequency

Q.4) A UGV is moving along a trajectory with following acceleration (m/s^2) in the inertial frame.

$$a_x(t) = 0.5\,cos(2t) \tag{1}$$

$$a_y(t) = 0.8\,sin(2t) \tag{2}$$

Find the acceleration measured in the body frame ($a_{xb}(t)$, $a_{yb}(t)$) and the yaw angle $\psi(t)$? Consider a time duration of 0 to 10 seconds with a sampling time interval of 0.01 seconds used for calculations. Assume suitable initial conditions for all the variables. Plot (as a function of time) the velocity and acceleration in both inertial and body frames and also the UGV position.