

Mechatronics System Design: Quiz I, 01/02/2025.

- Answer all the questions (5+5+5+5=20 marks).
- Time: 60 min (10:30 am to 11:30 am) .
- Calculator is allowed.
- Assume if any data found missing and mention your assumption in the answer.

Q.1) The dynamic characteristics of a sensor is given by the following differential equation

$$\frac{dy(t)}{dt} + 4y(t) = 4u(t) \quad (1)$$

Here $y(t)$ is the sensor output and $u(t)$ is the sensor input.

Find the dynamic measurement error (as a function of time) for

- Case A: $u(t) = 2$ and $y(0) = 0$ (2 marks)
- Case B: $u(t) = 2 \sin(2\pi t) + 4 \sin(3\pi t)$ and $y(0) = 0$ (3 marks)

Q.2) With appropriate equations and diagrams, explain the working of a hall effect sensor. (2 marks)

Derive the expression for the position estimate of a ground robot using a wheel encoder and a magnetometer. (3 marks)

Q.3) Explain the static and dynamic characteristics of a measurement system. (3+2=5 marks)

Q.4) Answer the following:

- Define a rigid body and explain its significance in kinematics. (1 mark)
- The degrees of freedom required to define a rigid body in 2D and 3D space are ——— and ———, respectively. (0.5 mark)
- List different types of links used in mechanisms. (0.5 mark)
- With a simple sketch, explain the degrees of freedom for different types of joints. (3 marks)