

1. (20%) For a DC motor, you can design an analog or digital controller for position control.
- Draw the block diagram and explain your design for analog controller. (7 points)
 - Draw the block diagram and explain your design for digital controller. (7 points)
 - Show the advantages of digital controller over analog controller. (6 points)

2. (20%) The system is given by

$$\ddot{y}(t) + 3\dot{y}(t) + 2y(t) = u(t)$$

Where the input $u(t) = \delta(t)$ is a unit impulse and the initial conditions

$$\dot{y}(0) = y(0) = 0$$

Obtain the response of the system using

- Laplace transform method. (10 points)
- State-variable method. (10 points)

3. (10%) When the following elements S or $\frac{1}{S}$ or e^{-Ts} appears on system block diagram, please explain the physical meanings, respectively.

4. (20%) A controlled process is represented by the following state equations:

$$\dot{x}_1 = x_1 - 3x_2$$

$$\dot{x}_2 = 5x_1 + u$$

The control is obtained from the feedback such that

$$u = -g_1x_1 - g_2x_2$$

where g_1 and g_2 are real constants.

- Find the locus in the g_1 versus g_2 plane on which the overall system has a natural frequency of $\sqrt{2}$ rad/sec. (6 points)
- Find the locus in the g_1 versus g_2 plane on which the overall system has a damping ratio of 70.7 per cent. (7 points)
- Find the values of g_1 and g_2 such that $\zeta = 0.707$ and $\omega_n = \sqrt{2}$ rad/sec. (7 points)

5. (30%) Explain the following terminology, (3 points each)
- (a) Time-invariant system
 - (b) Causal system
 - (c) Linear system
 - (d) Phase margin
 - (e) Gain margin
 - (f) Full rank matrix
 - (g) State transition matrix
 - (h) Relative stability
 - (i) Principle of argument
 - (j) Dead zone