

Princess Sumaya University for Technology	 جامعة سميرة Princess Sumaya University for Technology للتكنولوجيا	جامعة الأميرة سميرة للتكنولوجيا
Automatic Control	Student Name:	
Quiz 2	Student ID No.: 20231155	
Date: Summer 12/07/2026	Grade: 9	

Q1.a The step response of a control system is given by: $y(t) = [1 - 2e^{-t} + e^{-2t}]u_s(t)$. Find the transfer function of the system (2 point)

$$\hookrightarrow \left(\frac{1}{s} - \frac{2}{s+1} + \frac{1}{s+2} \right) = s \left(\frac{(s+1)(s+2) - 2s(s+2) + s(s+1)}{s(s+1)(s+2)} \right)$$

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Q1.b

i) The transfer function of a control system is given by:

$$\frac{Y(s)}{R(s)} = \frac{16}{(s+4)^2}, \text{ find the impulse response of this system (2 points)}$$

$$Y(s) = G(s) = \frac{16}{(s+4)^2} = \frac{B_0}{(s+4)^2} + \frac{B_1}{(s+4)}$$

$$B_0 = \lim_{s \rightarrow -4} (s+4)^2 \cdot \frac{16}{(s+4)^2} = 16, B_1 = \frac{d}{ds} \left[(s+4)^2 \cdot \frac{16}{(s+4)^2} \right] = 0$$

$$G(s) = \frac{16}{(s+4)^2} \xrightarrow{s^{-1}} 16t e^{-4t}$$

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Q1.c A linear control system is given by:

$$\frac{Y(s)}{R(s)} = \frac{12s^2 - 6s + 10}{2s^3 + 4s^2 - 8}, \text{ provide a state space representation for the system (2 points)}$$

$$= \frac{Y(s)}{R(s)} = \frac{6s^2 - 3s + 5}{s^3 + 2s^2 + 0s - 4}$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 4 & 0 & -2 \end{bmatrix}, b = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, c = \begin{bmatrix} 5 & -3 & 6 \end{bmatrix}$$

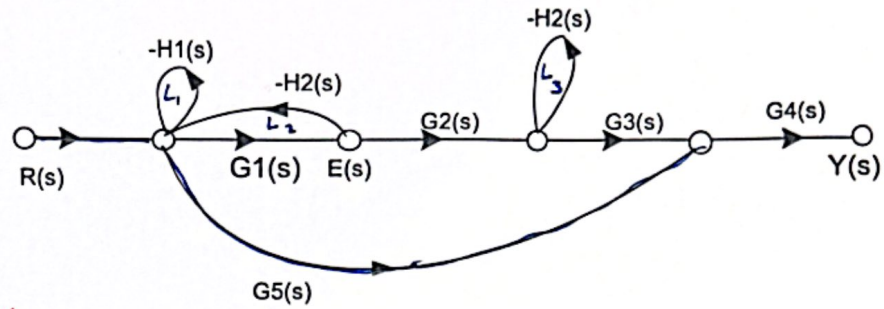
$$\dot{\bar{x}} = A \bar{x} + b r(t)$$

$$y = c \bar{x}$$

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Q3) a) Use the gain formula to find $\frac{Y(s)}{R(s)}$

(4 points)



FWD paths

$$M_{11} = G_1 G_2 G_3 G_4$$

$$M_{12} = G_5 G_4$$

$$L_1 = -H_1, L_2 = -G_1 H_2, L_3 = -H_2$$

$$\Delta = 1 - \sum (\text{loop gains}) = 1 - (L_1 + L_2 + L_3) + (L_1 L_3 + L_2 L_3)$$

$$\Delta_{11} = 1, \Delta_{12} = 1 - L_3$$

$$\frac{Y(s)}{R(s)} = \frac{M_{11} \Delta_{11} + M_{12} \Delta_{12}}{\Delta}$$

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