

POSTAL Book Package

2023

GATE • PSUs

Instrumentation Engineering

Objective Practice Sets

Control Systems and Process Control

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Block Diagram and Transfer Function

MCQ and NAT Questions

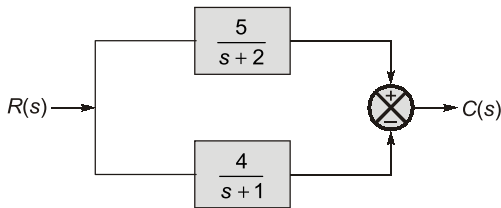
Q.1 Consider the following open-loop transfer function:

$$G = \frac{K(s+2)}{(s+1)(s+4)}$$

The characteristic equation of the unity negative feedback will be

- (a) $(s+1)(s+4) + K(s+2) = 0$
- (b) $(s+2)(s+1) + K(s+4) = 0$
- (c) $(s+1)(s-2) + K(s+4) = 0$
- (d) $(s+2)(s+4) + K(s+1) = 0$

Q.2 For the given figure,



- (a) $\frac{4(s+2)}{(s+2)(s+1)}$
- (b) $\frac{(s-3)}{(s+2)(s+1)}$
- (c) $\frac{9s+13}{(s+2)(s+1)}$
- (d) $\frac{1}{(s+2)(s+1)}$

Q.3 The transfer function of three blocks connected in cascade is given by $\frac{(s+1)}{s(s+2)(s+3)}$. If block 1

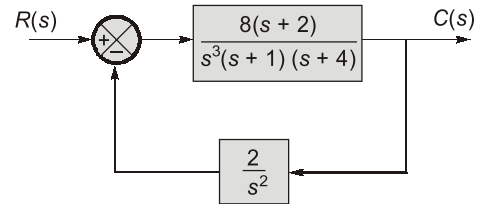
has transfer function of $\frac{1}{s(s+2)}$ and block 2 has

transfer function of $\frac{1}{s(s+2)}$ and block 2 has

transfer function of $\frac{(s+2)}{(s+3)}$ then the transfer function of the 3rd block is

- (a) $(s+1)(s+2)$
- (b) $\frac{(s+1)}{(s+2)}$
- (c) $\frac{(s+1)}{s(s+3)}$
- (d) $\frac{(s+1)^2}{(s+2)^2}$

Q.4 The type of the control system represented by the block diagram shown below is



- (a) Type-2
- (b) Type-3
- (c) Type-4
- (d) Type-5

Q.5 Match **List-I (Transfer Function of the System)** with **List-II (Type and Order of the System)** and select the correct answer using the codes given below the lists:

List-I

List-II

- | | |
|---|---|
| <p>A. $\frac{2(s+2)}{s(s+5)}$</p> <p>B. $\frac{(s+2)}{(s+3)(s+5)}$</p> <p>C. $\frac{2(s+5)}{s^2(s+2)}$</p> <p>D. $\frac{5(s+2)}{(s+1)(s+3)(s+5)}$</p> | <p>1. Type 0, second order</p> <p>2. Type 1, second order</p> <p>3. Type 0, third order</p> <p>4. Type 2, third order</p> |
|---|---|

Codes:

- | | | | |
|----------|----------|----------|----------|
| A | B | C | D |
| (a) 2 | 1 | 4 | 3 |
| (b) 4 | 3 | 2 | 1 |
| (c) 2 | 3 | 4 | 1 |
| (d) 4 | 1 | 2 | 3 |

Q.6 The closed-loop transfer function of a unity feedback control system is $\frac{25}{s^2 + 10s + 25}$. What

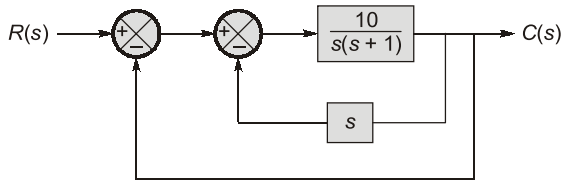
is the open loop transfer function of the system?

- (a) $\frac{25}{s^2 + 10s}$
- (b) $\frac{25}{s^2 + 25}$
- (c) $\frac{25}{s + 25}$
- (d) $\frac{25}{s + 10}$

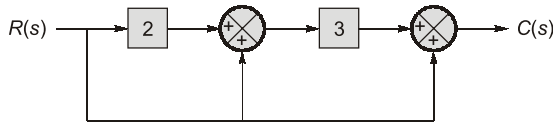
Q.23 For the system in figure the transfer function $\frac{C(s)}{R(s)}$

is given as $\frac{C(s)}{R(s)} = \frac{P}{s^2 + Rs + Q}$.

Then value of $P + R + Q$ will be _____.



Q.24 For the given block diagram, the value of $\frac{C(s)}{R(s)}$ will be _____.

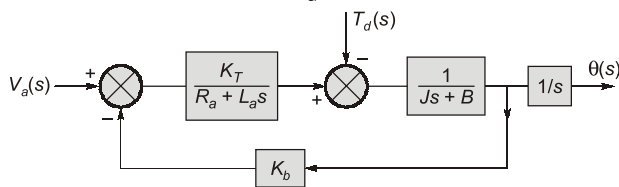


Q.25 The step response of a system is given by,

$$c(t) = \left[1 - \frac{1}{15}e^{-3t} + 7e^{-5t} \right]$$

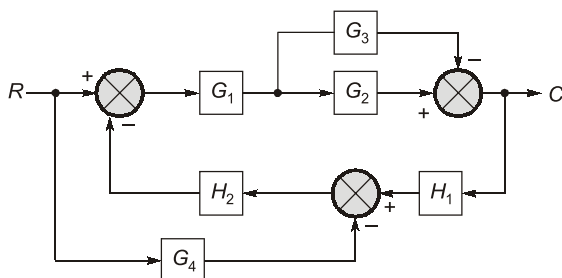
The DC gain of the system is _____.

Q.26 The position control of a DC servo-motor is given in the figure. The values of the parameters are $K_T = 1$ N-m A, $R_a = 1$ W, $L_a = 0.1$ H. $J = 5$ kg-m², $B = 1$ N-m (rad/sec) and $K_b = 1$ V/(rad/sec). The steady-state position response (in radians) due to unit impulse disturbance torque T_d is _____.



Multiple Select Questions (MSQs)

Q.27 Which of the following statement(s) is/are correct about the control system whose block diagram is shown below:



(a) For the above block diagram, the signal flow graph has four forward paths.

(b) For the above block diagram, the signal flow graph has two loops.

(c) Transfer function

$$\frac{C}{R} = \frac{G_1 G_2 - G_1 G_3 + G_1 G_2 G_4 H_2 - G_1 G_3 G_4 H_2}{1 + G_1 G_2 H_1 H_2 - G_1 G_3 H_1 H_2}$$

(d) Transfer function

$$\frac{C}{R} = \frac{G_1 G_2 + G_1 G_3 + G_1 G_2 G_4 H_2 + G_1 G_3 G_4 H_2}{1 + G_1 G_2 H_1 H_2 + G_1 G_3 H_1 H_2}$$

Q.28 Which of the following statements are correct regarding transfer function.

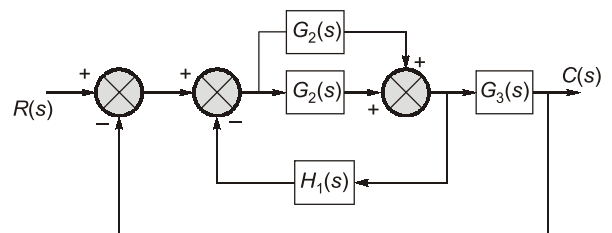
(a) The transfer function is defined only for a linear time-invariant system.

(b) The transfer function is defined for both linear and nonlinear systems.

(c) The transfer function is independent of the input of the system.

(d) The transfer function of a linear time-invariant system is Laplace transform of the impulse response with all the initial conditions set to zero.

Q.29 The overall closed loop transfer function $\frac{C(s)}{R(s)}$ represented in the figure will be



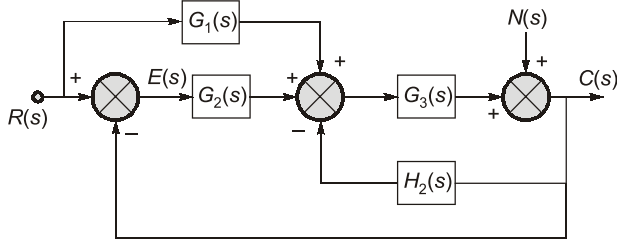
(a) $\frac{C(s)}{R(s)} = \frac{(G_1(s) + G_2(s))G_3(s)}{1 + (G_1(s) + G_2(s))(H_1(s) + G_3(s))}$

(b) $\frac{C(s)}{R(s)} = \frac{(G_1(s) + G_2(s))G_3(s)}{1 + G_1(s)H_1(s) + G_2(s)G_3(s)}$

(c) $\frac{C(s)}{R(s)} = \frac{G_1(s) + G_2(s)}{1 + G_1(s)H_1(s) + G_2(s)H_1(s)}$

(d) $\frac{C(s)}{R(s)} = \frac{G_1(s)G_3(s) + G_2(s)G_3(s)}{1 + G_1(s)H_1(s) + G_2(s)H_1(s) + G_1(s)G_3(s) + G_2(s)G_3(s)}$

Q.30 The block diagram of a control system is shown in figure.



Which of the following statements is/are true?

- (a) $\left. \frac{C(s)}{R(s)} \right|_{N(s)=0} = \frac{G_1 G_3 + G_2 G_3}{1 + G_3 H_1 + G_2 G_3}$
 (b) $\left. \frac{C(s)}{N(s)} \right|_{R(s)=0} = \frac{G_1 G_3 + G_2 G_3}{1 + G_3 H_1 + G_2 G_3}$
 (c) $\left. \frac{C(s)}{N(s)} \right|_{R(s)=0} = \frac{1}{1 + G_3 H_1 + G_2 G_3}$
 (d) $\left. \frac{C(s)}{R(s)} \right|_{N(s)=0} = \frac{1}{1 + G_3 H_1 + G_2 G_3}$



Answers Block Diagram and Transfer Function

- | | | | | | | |
|------------|------------|----------|---------|------------|---------------|---------------|
| 1. (a) | 2. (b) | 3. (b) | 4. (d) | 5. (a) | 6. (a) | 7. (c) |
| 8. (c) | 9. (a) | 10. (a) | 11. (b) | 12. (d) | 13. (c) | 14. (b) |
| 15. (b) | 16. (d) | 17. (c) | 18. (b) | 19. (d) | 20. (d) | 21. (c) |
| 22. (1) | 23. (31) | 24. (10) | 25. (1) | 26. (-0.5) | 27. (a, b, c) | 28. (a, c, d) |
| 29. (a, d) | 30. (a, c) | | | | | |

Explanations Block Diagram and Transfer Function

1. (a)

$$q(s) = 1 + G(s)H(s) = 0$$

$$q(s) = 1 + \frac{K(s+2)}{(s+1)(s+4)} = 0$$

$$q(s) = (s+1)(s+4) + K(s+2) = 0$$

2. (b)

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)} \quad \dots \text{ For negative feedback}$$

$$\frac{C(s)}{R(s)} = G_1(s) + G_2(s) \quad \dots \text{ For parallel feedback}$$

$$G_1(s) = \frac{5}{s+2}$$

$$G_2(s) = -\frac{4}{s+1}$$

$$\frac{C(s)}{R(s)} = \frac{5}{s+2} - \frac{4}{s+1} = \frac{s-3}{(s+1)(s+2)}$$

3. (b)

As the three blocks are connected in cascade the overall transfer function is given by the multiplication of individual blocks.

$$\therefore x_1 \times x_2 \times x_3 = \frac{(s+1)}{s(s+2)(s+3)}$$

$$\frac{1}{s(s+2)} \times \frac{(s+2)}{(s+3)} \times x_3 = \frac{(s+1)}{s(s+2)(s+3)}$$

$$x_3 = \frac{(s+1)}{(s+2)}$$

4. (d)

The type of the system = Number of open loop poles at origin

$$\therefore G(s)H(s) = \frac{8(s+2)}{s^3(s+1)(s+4)} \times \frac{2}{s^2} = \frac{16(s+2)}{s^5(s+1)(s+4)}$$

\therefore Type-5.