

# GATE CH-23 44

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Q: A cascade control strategy is shown in the figure below. The transfer function between the output ( $y$ ) and the secondary disturbance ( $d_2$ ) is defined as

$$G_{d2}(s) = \frac{y(s)}{d_2(s)}$$

Which one of the following is the CORRECT expression for the transfer function  $G_{d2}(s)$ ?

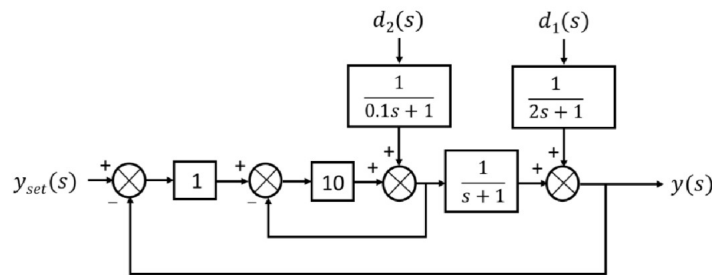


Fig. 0.

- A.  $\frac{1}{(11s+21)(0.1s+1)}$
- B.  $\frac{1}{(s+1)(0.1s+1)}$
- C.  $\frac{(s+2)(0.1s+1)}{(s+1)}$
- D.  $\frac{(s+1)}{(s+1)(0.1s+1)}$

**Solution:**

Variable	Description
$d_1(s)$	Primary disturbance
$d_2(s)$	Secondary disturbance
$G_{d2}(s)$	Transfer function between $y(s)$ and $d_2(s)$
$y_{set}(s)$	Set point for desired output
$y(s)$	Output

TABLE 4

INPUT PARAMETERS

Variable	Description
$a(s)$	Error signal

TABLE 4

DEFINED PARAMETERS

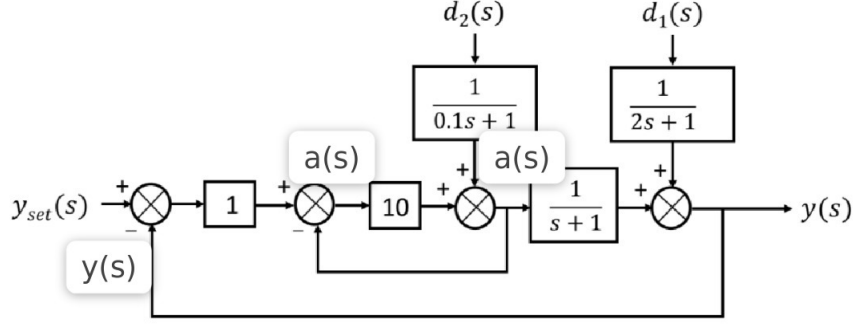


Fig. 4.

$$\left[ (y_{sp} - y(s)) (1) - a(s) \right] 10 + d_2(s) \frac{1}{0.1s + 1} = a(s) \quad (1)$$

$$a(s) \left( \frac{1}{s + 1} \right) + d_1(s) \frac{1}{(2s + 1)} = y(s) \quad (2)$$

From (??)

$$(y_{sp} - y(s)) 10 - 10a(s) + d_2(s) \frac{1}{0.1s + 1} = a(s) \quad (3)$$

$$(y_{sp} - y(s)) \frac{10}{11} + \frac{d_2(s)}{11(0.1s + 1)} = a(s) \quad (4)$$

Substituting (4) in (2)

$$\left[ (y_{sp} - y(s)) \frac{10}{11} + \frac{d_2(s)}{11(0.1s + 1)} \right] \frac{1}{(s + 1)} + d_1(s) \frac{1}{(2s + 1)} = y(s) \quad (5)$$

$$(0 - y(s)) \frac{10}{11} \frac{1}{(s + 1)} + \frac{d_2(s)}{11(0.1s + 1)(s + 1)} = y(s) \quad (6)$$

$$\frac{d_2(s)}{11(0.1s + 1)(s + 1)} = y(s) \left( \frac{11(s + 1) + 10}{11(s + 1)} \right) \quad (7)$$

$$\frac{d_2 s}{(0.1s + 1)} = y(s) [11s + 21] \quad (8)$$

$$\frac{y(s)}{d_2(s)} = \frac{1}{(0.1s + 1)(11s + 21)} \quad (9)$$

$$\Rightarrow G_{d2}(s) = \frac{1}{(0.1s + 1)(11s + 21)} \quad (10)$$

Now taking the inverse laplace transform we have,

$$G_{d2}(t) = \mathcal{L}^{-1} \left( \frac{10}{(s + 10)(11s + 21)} \right) \quad (11)$$

$$= \mathcal{L}^{-1} \left( \frac{-10}{89(s + 10)} + \frac{110}{89(11s + 21)} \right) \quad (12)$$

$$= \frac{-10e^{-10t}}{89} + \frac{10e^{-\frac{21}{11}t}}{89} \quad (13)$$

$$= \frac{10 \left( e^{-\frac{21}{11}t} - e^{-10t} \right)}{89} \quad (14)$$

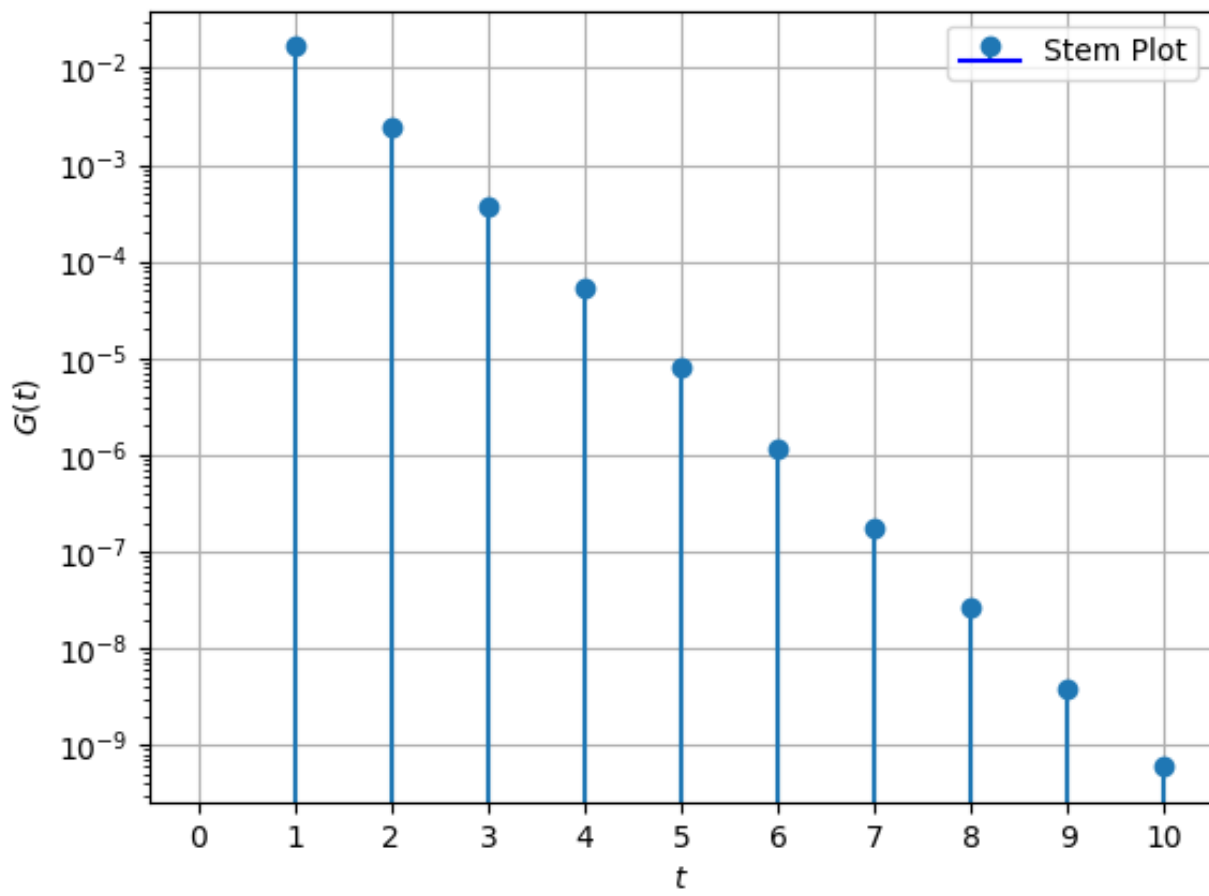


Fig. 4.