

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 $G_{d2}(s)$?

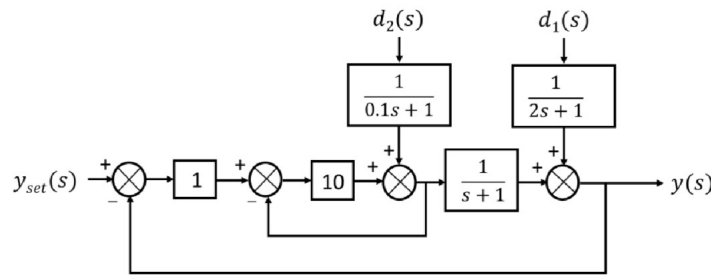


Fig. 0.

- A. $\frac{1}{(11s+21)(0.1s+1)}$
- B. $\frac{1}{(s+1)(0.1s+1)}$
- C. $\frac{(s+1)}{(s+2)(0.1s+1)}$
- 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 $d_2(s)$

TABLE 4

INPUT PARAMETERS

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

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

From (1)

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

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

$$(y_{sp} - y) \frac{10}{11} + \frac{d_2(s)}{11(0.1s + 1)} = a \quad (5)$$

Substituting (5) in (2)

$$\left[(y_{sp} - y) \frac{10}{11} + \frac{d_2(s)}{11(0.1s + 1)} \right] \frac{1}{(s + 1)} + d_1(s) \frac{1}{(2s + 1)} = y \quad (6)$$

$$(y_{sp} - y) \frac{10}{11} \frac{1}{(s + 1)} + \frac{d_2(s)}{11(0.1s + 1)(s + 1)} + d_1(s) \frac{1}{(2s + 1)} = y \quad (7)$$

$$(0 - y) \frac{10}{11} \frac{1}{(s + 1)} + \frac{d_2(s)}{11(0.1s + 1)(s + 1)} = y \quad (8)$$

$$\frac{d_2(s)}{11(0.1s + 1)(s + 1)} = y + \frac{10}{11} y \frac{1}{(s + 1)} \quad (9)$$

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

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

$$\frac{d_2 s}{(0.1s + 1)} = y(s) [11s + 11 + 10] \quad (12)$$

$$\frac{d_2 s}{(0.1s + 1)} = y(s) [11s + 21] \quad (13)$$

$$\frac{y(s)}{d_2 s} = \frac{1}{(0.1s + 1)(11s + 21)} \quad (14)$$

$$\Rightarrow G_{d2}(s) = \frac{1}{(0.1s + 1)(11s + 21)} \quad (15)$$