GATE CH-23 44

EE23BTECH11011- Batchu Ishitha*

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

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

.

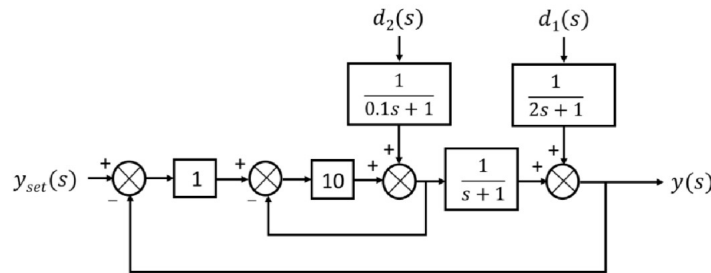Which one of the following is the CORRECT expression for the transfer function $G_{d2}(s)$?

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	Value
$y(s)$	output	none
$d_2(s)$	Secondary disturbance	none
$G_{d2}(s)$	Transfer function between $y(s)$ and $d_2(s)$	$\frac{y(s)}{d_2(s)}$

TABLE 4

INPUT PARAMETERS

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

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

From (1)

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

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

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

Substituting (5) in (2)

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

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

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

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

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

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

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

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

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

$$\implies G_{d2}(s) = \frac{1}{(0.1s + 1)\,(11s + 21)} \tag{15}$$