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 $G_{d2}(s)$?

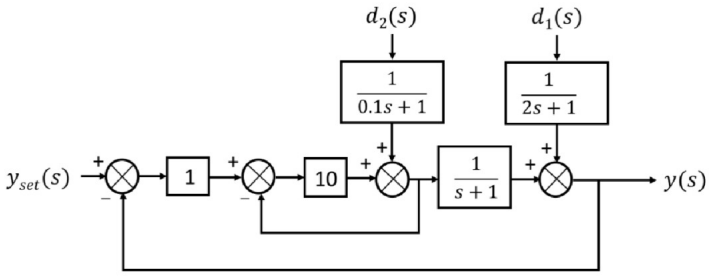

Fig. 0.

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	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)

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

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

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

Substituting (5) in (2)

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

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

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

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

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

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

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

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

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

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