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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 $G_{d2}(s)$?

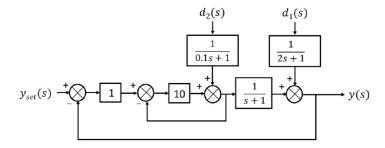


Fig. 0.

A. $\frac{1}{(11s+21)(0.1s+1)}$

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 $d_2(s)$	
$y_{set}(s)$	Set point for desired output	
<i>y</i> (<i>s</i>)	Output	

TABLE 4
INPUT PARAMETERS

Variable	Description		
a(s)	Error signal		
TABLE 4			
Defined Parameters			

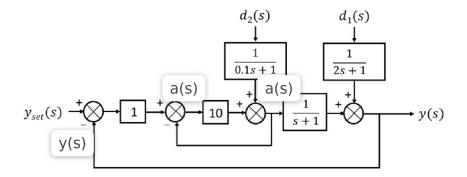


Fig. 4.

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

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

From (1)

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

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

Substituting (4) in (2)

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

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

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

$$\frac{d_2s}{(0.1s+1)} = y(s) [11s+21] \tag{8}$$

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

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

Now taking the inverse laplace transform we have,

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

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

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

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

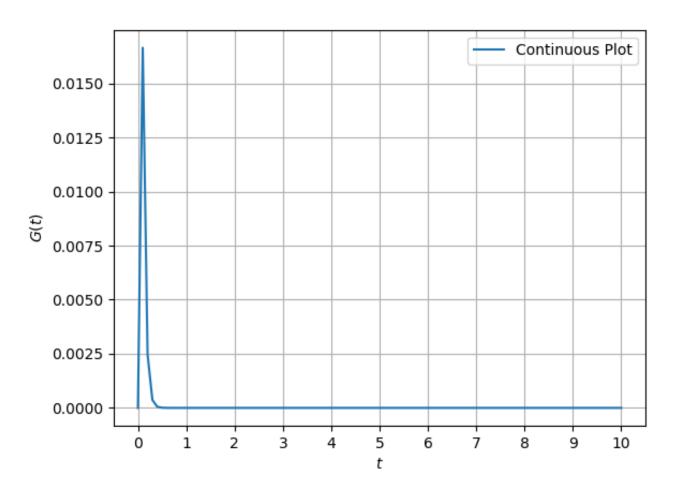


Fig. 4.