

# 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  $G_{d2}(s)$ ?

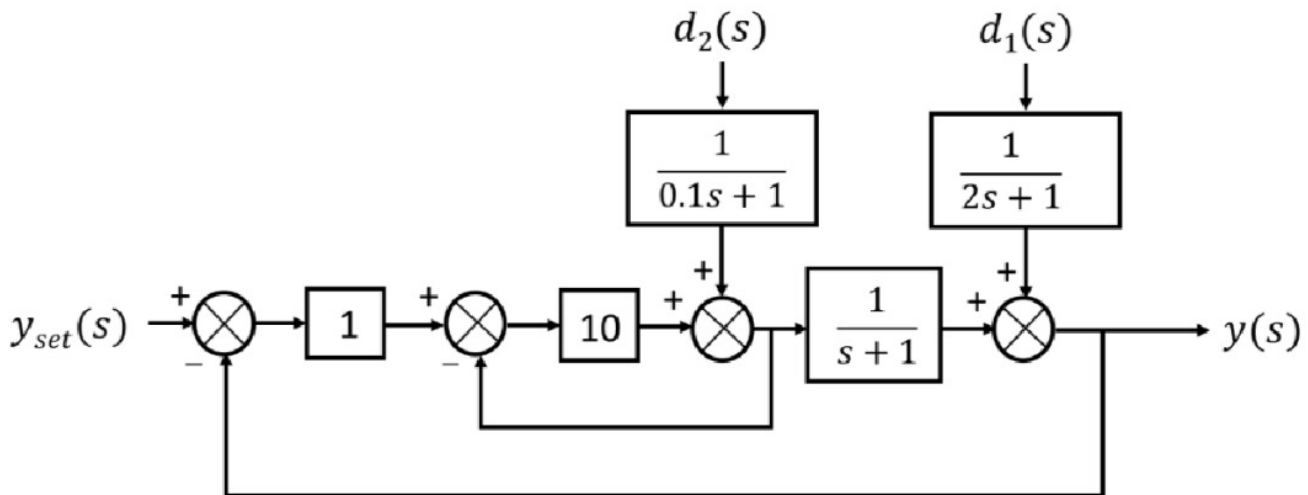


Fig. 0.

- 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 $d_2(s)$
$y_{set}(s)$	Set point for desired output
$y(s)$	Output

TABLE 4  
INPUT PARAMETERS

Variable	Description	value
$P_1$	Forward path gain e-c-d	$\frac{1}{(0.1s+1)(s+1)}$
$\Delta_1$	Determinant of forward path e-c-d	1
$\Delta$	Determinant of system	$1 + \frac{10}{s+1} + 10$
$n$	Number of forward path	1

TABLE 4  
DEFINED PARAMETERS

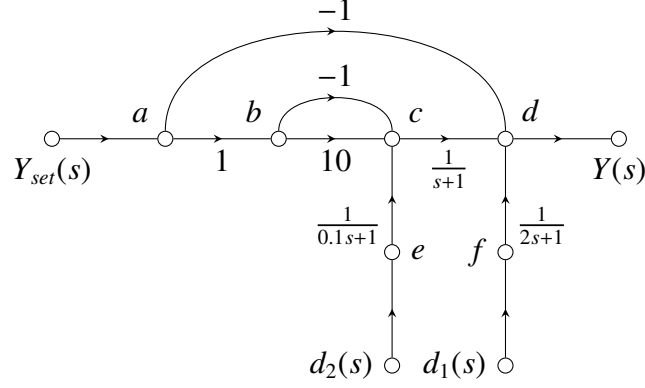


Fig. 4. signal flow graph

Using Mason's Gain formula for the above Signal flow graph,

$$G_{d2}(s) = \frac{y(s)}{d_2(s)} = \frac{\sum_{i=1}^n P_i \Delta_i}{\Delta} \quad (1)$$

$$= \frac{P_1 \Delta_1}{\Delta} \quad (2)$$

$$= \frac{\frac{1}{(0.1s+1)(s+1)}}{1 + \frac{10}{s+1} + 10} \quad (3)$$

$$= \frac{\frac{1}{(0.1s+1)(s+1)}}{\frac{11s+21}{s+1}} \quad (4)$$

$$\Rightarrow G_{d2}(s) = \frac{1}{(11s+21)(0.1s+1)} \quad (5)$$

Now taking the inverse laplace transform we have,

$$G_{d2}(t) = \mathcal{L}^{-1} \left( \frac{10}{(s+10)(11s+21)} \right) \quad (6)$$

$$= \mathcal{L}^{-1} \left( \frac{-10}{89(s+10)} + \frac{110}{89(11s+21)} \right) \quad (7)$$

$$= \frac{-10e^{-10t}}{89} + \frac{10e^{-\frac{21t}{11}}}{89} \quad (8)$$

$$= \frac{10 \left( e^{-\frac{21t}{11}} - e^{-10t} \right)}{89} \quad (9)$$

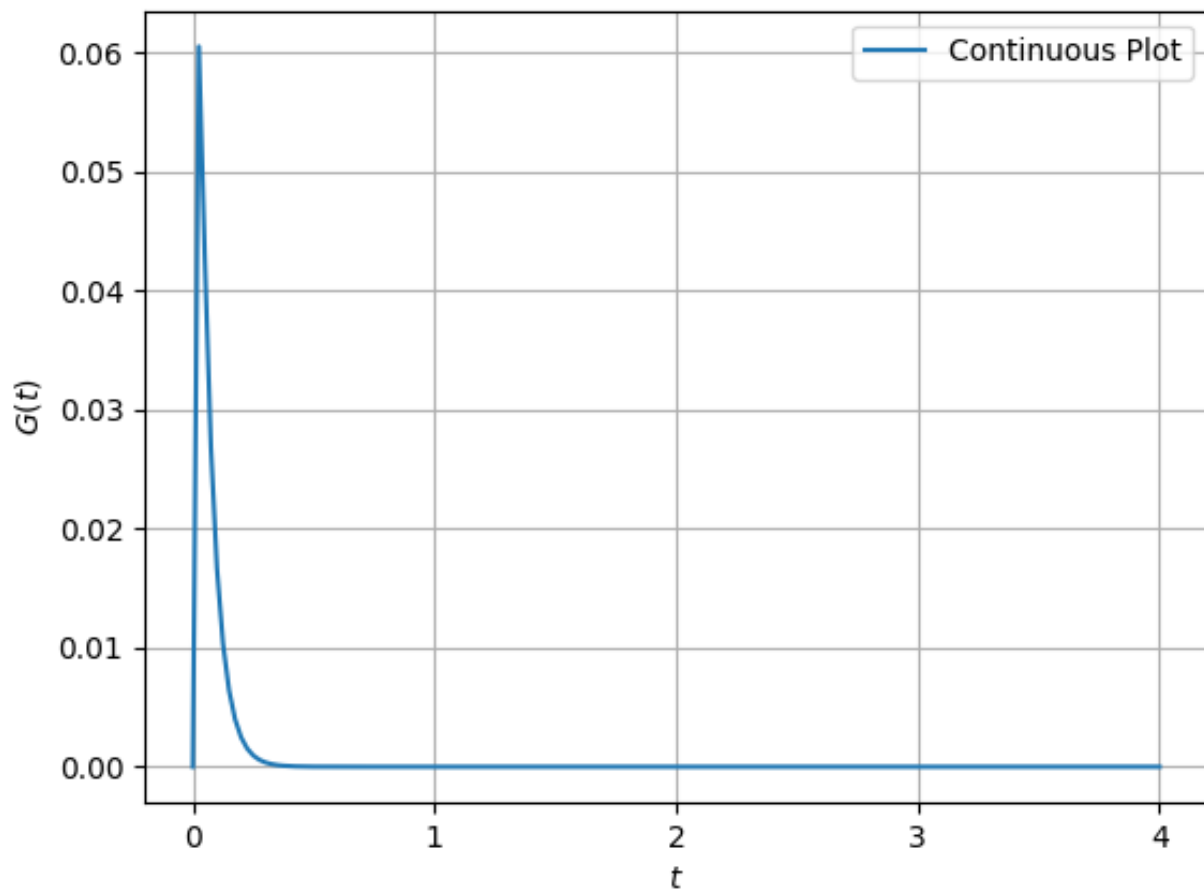


Fig. 4.