Question 23, CH Gate 2022

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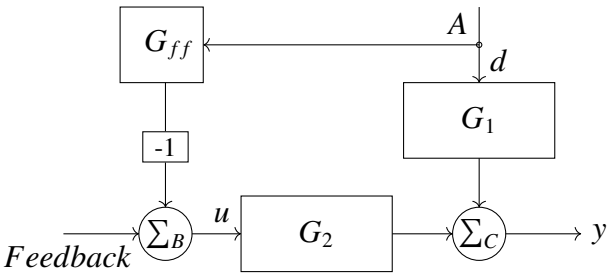
Question: The appropriate feedforward compensator, G_{ff}, in the shown block diagram is



Solution:

Symbol	Value	Description
y	-	Signal
d	-	Disturbance
G_1	$\frac{2e^{-s}}{5s+1}$	Transfer functions
G_2	$\frac{3e^{-s}}{8s+1}$	

TABLE 0
Input Parameters

In an ideal system, the output y must be independent of the disturbance d. This means, the transfer function

$$\frac{Y(s)}{D(s)} = 0$$

At B,

$$U(s) = -Y(s) - G_{ff}(s) D(s) \tag{1}$$

At C,

$$Y(s) = G_1(s) D(s) + G_2(s) U(s) \tag{2}$$

From (1) and (2),

$$Y(s) = G_1(s) D(s) + G_2(s) \left(-Y(s) - G_{ff}(s) D(s)\right) \tag{3}$$

$$\implies (1 + G_2) Y(s) = D(s) \left(G_1(s) - G_2(s) G_{ff}(s)\right) \tag{4}$$

$$\implies \frac{Y(s)}{D(s)} = \frac{G_1(s) - G_2(s) G_{ff}(s)}{1 + G_2} \tag{5}$$

For this system to be ideal, and from Table 0

$$\frac{G_1(s) - G_2(s) G_{ff}(s)}{1 + G_2} = 0 \tag{6}$$

$$\implies G_{ff}(s) = \frac{G_1}{G_2} \tag{7}$$

$$\implies G_{ff}(s) = \frac{2}{3}\frac{8s+1}{5s+1} \tag{8}$$