GATE 2023 EC

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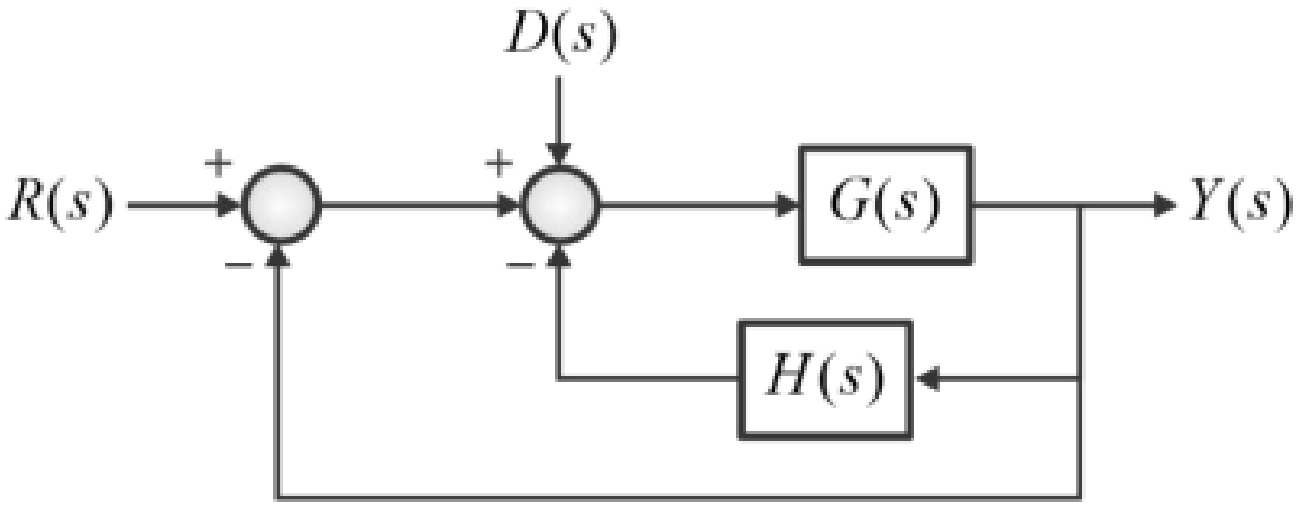
Question: 42 In the following block diagram, $R(s)$ and $D(s)$ are two inputs. The output Y(s) is expressed as $Y(s) = G_1(s)R(s) + G_2(s)D(s)$.
$G_1(s)$ and $G_2(s)$ are given by



a) $G_1(s) = \frac{G(s)}{1+G(s)+G(s)H(s)}$ and $G_2(s) = \frac{G(s)}{1+G(s)+G(s)H(s)}$

b) $G_1(s) = \frac{G(s)}{1+G(s)+H(s)}$ and $G_2(s) = \frac{G(s)}{1+G(s)+H(s)}$

c) $G_1(s) = \frac{G(s)}{1+G(s)+H(s)}$ and $G_2(s) = \frac{G(s)}{1+G(s)+G(s)H(s)}$

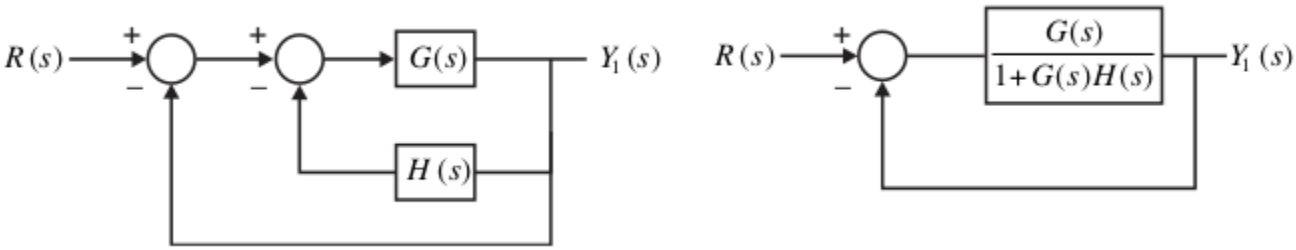
d) $G_1(s) = \frac{G(s)}{1+G(s)+G(s)H(s)}$ and $G_2(s) = \frac{G(s)}{1+G(s)+H(s)}$

Solution:
Let $Y(s) = Y_1(s) + Y_2(s)$, where $Y_1(s)$= output considering only $R(s)$, $Y_2(s)$ = Output considering only $D(s)$

When only R(s) is present:

$$\frac{Y_1(s)}{R(s)} = \frac{\frac{G(s)}{1+G(s)H(s)}}{1+\frac{G(s)}{1+G(s)H(s)}} \tag{1}$$

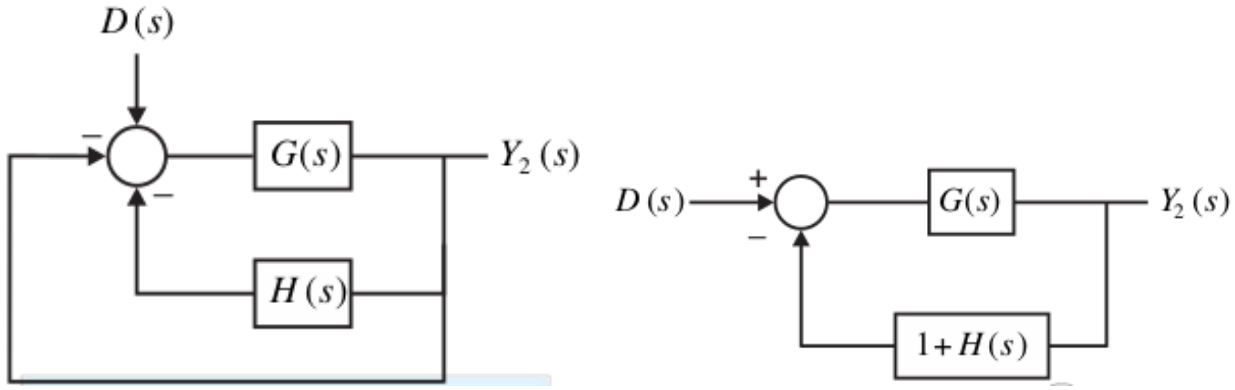
$$Y_1(s) = \left[\frac{G(s)}{1+G(s)+G(s)H(s)}\right]R(s) \tag{2}$$



Hence,

$$G_1(s) = \frac{G(s)}{1 + G(s) + G(s)H(s)} \tag{3}$$

When only $D(s)$ is present,



$$\frac{Y_2(s)}{D(s)} = \frac{G(s)}{1 + G(s)[1 + H(s)]} \tag{4}$$

$$Y_2(s) = \left[\frac{G(s)}{1 + G(s)[1 + H(s)]}\right] D(s) \tag{5}$$

Hence,

$$G_2(s) = \frac{G(s)}{1 + G(s) + G(s)H(s)} \tag{6}$$

Option (a) is correct