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Gate Problem

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Problem Statement

- EE-2016-Set-1

Question 30: Consider the following asymptotic Bode magnitude plot (ω is in rad/s).

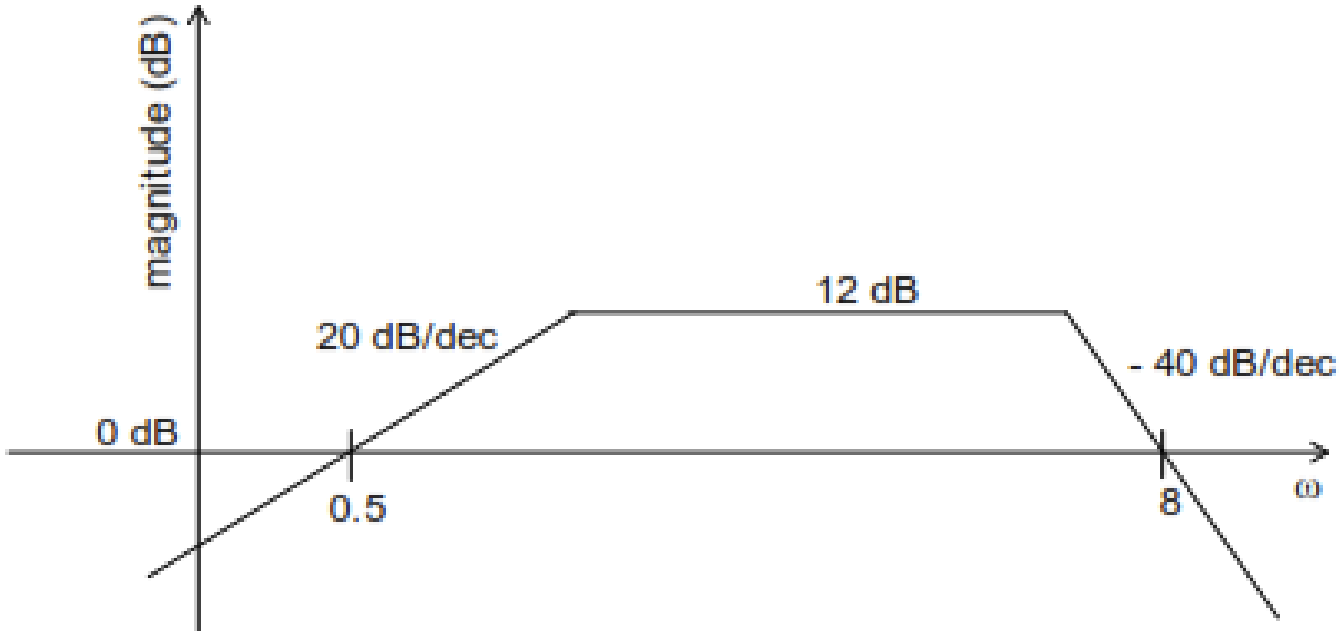


Figure 1: Bode Plot

Which of the following transfer function is best represented by the above Bode magnitude plot?

(A) $\dfrac{2s}{(1+0.5s)(1+0.25s)^2}$

$(B)\dfrac{4(1+0.5s)}{s(1+0.25s)}$

(C) $\dfrac{2s}{(1+2s)(1+4s)}$

$(D)\dfrac{4s}{(1+2s)(1+4s)^2}$

Solution:

- By looking to the plot, we can say that since the initial slope is $+20$, there must bea zero at the origin.
- Let the corner frequencies of the plot be ω_{01} and ω_{02}. They can be calculated as follows: slope $= \dfrac{M_2 - M_1}{log\omega_2 - log\omega_1}$

  Therefore for ω_{02},

  -40 $= \dfrac{0 - 12}{log8 - log\omega_{02}}$

  log8 - logω_{02} $= \dfrac{12}{40}$

  logω_{02} = log8 - $\dfrac{12}{40}$

  $\omega_{02} = 4$

- Therefore for ω_{01},

  $$20 = \frac{0 - 12}{log0.5 - log}\omega_{01}$$

  $$\log 0.5 - \log\omega_{01} = \frac{-12}{20}$$

  $$\log\omega_{01} = \log 0.5 + \frac{12}{20}$$

  $$\omega_{01} = 2$$

- So, the corner frequencies are ω_{01}=2 and $\omega_{02} = 4$.
- At ω_{01}, the change in slope is -20dB, so their exists one pole at this frequency and at ω_{02}, the change in slope is -40dB, so their exists two pole at this frequency.

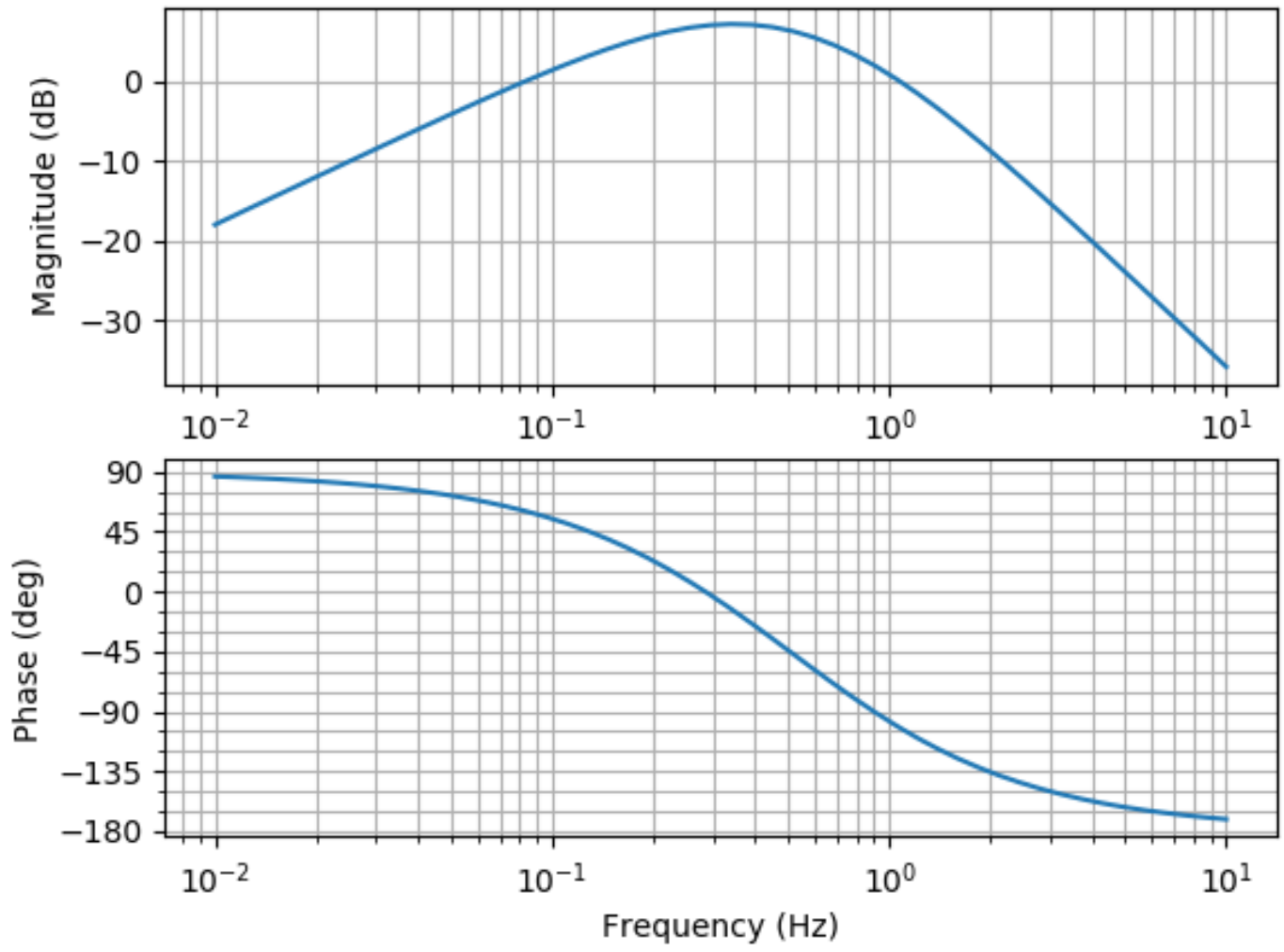
- The denominators have the form $(1 + \frac{s}{\omega})$

- So, the denominator of the transfer function is $(1 + \frac{s}{2})(1 + \frac{s}{4})^2$
- Therefore, the transfer function is $\frac{sc}{(1 + \frac{s}{2})(1 + \frac{s}{4})^2}$ where c is some constant

- The answer is therefore option (A) $\frac{2s}{(1 + 0.5s)(1 + 0.25s)^2}$

Verification

- We will now plot the bode plot of the given transfer function.
- The bode plot is:



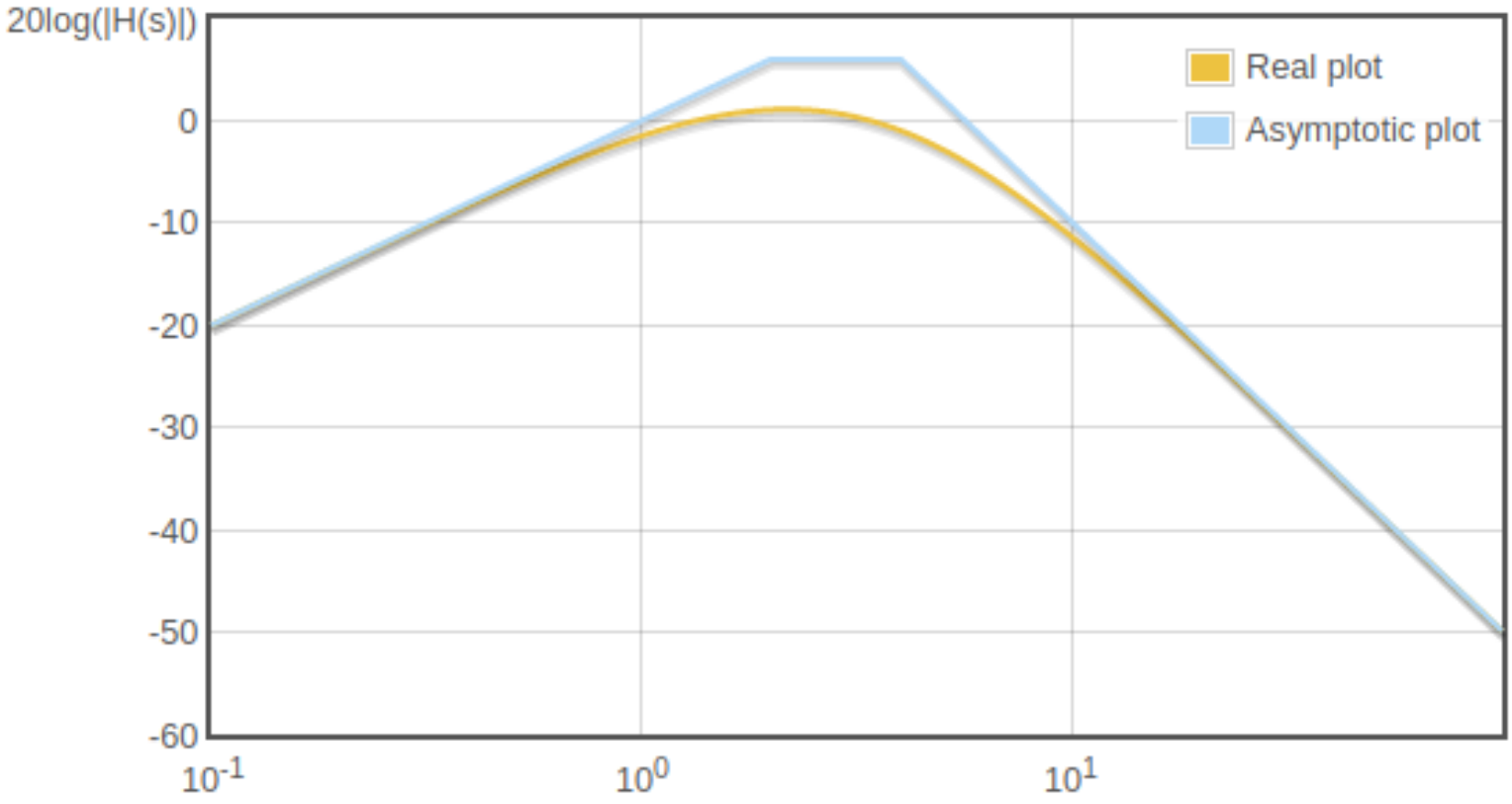

20log(|H(s)|)
0
-10
-20
-30
-40
-50
-60
10^{-1}
10^{0}
10^{1}
Real plot
Asymptotic plot

Figure 3: