Paper 3C1

Examples Sheet 5: Frequency Response

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http://www.mee.tcd.ie/~sigmedia

1. A sinusoidal input is applied to a system with transfer function

$$H(s) = \frac{1}{(s+1)(s+0.1)}$$

At which frequency does the output lag behind the input by 90°? if the input amplitude is X, what is the output amplitude at this frequency?

2. Given the following transfer functions:

$$G_1(s) = \frac{1+sT}{1+asT} \; ; \qquad G_3(s) = \frac{1}{1+2c_3sT_3+s^2T_3^2} \text{ For } c_3 = 0.1, \; T_3 = 10.$$

and the Bode diagram of G_3 in figure 1, draw on the figure 2 the Bode diagram of the transfer function of G_1 and G_3 in cascade with (a) $a = 0.1, T = 1$ and (b) $a = 4, T = 2.5$ (drawing the effects of asymptotes only will suffice).

3. In the last question of Examples Paper 2, the transmission path through a telephone network was modelled as a system with impulse response $\beta e^{-\beta t}$ and transfer function (taking $\beta = 22000$):

$$\begin{aligned} H_1(s) &= \mathcal{L}\left\{\beta e^{-\beta t}\right\} \\ &= \frac{\beta}{s+\beta} \\ &= \frac{22000}{s+22000} \end{aligned}$$

A better model is given by the transfer function:

$$H_2(s) = \frac{22000s}{(s+300)(s+22000)}$$

The Bode diagrams for the two models are given figures 3 and 4.

A sinusoidal signal of frequency ω rad/sec is transmitted through the network. Using the Bode diagrams, estimate the range of values of ω for which the received signal would be attenuated by less than $1/\sqrt{2}$, according to each of the two models. What kind of filter does each system represent?

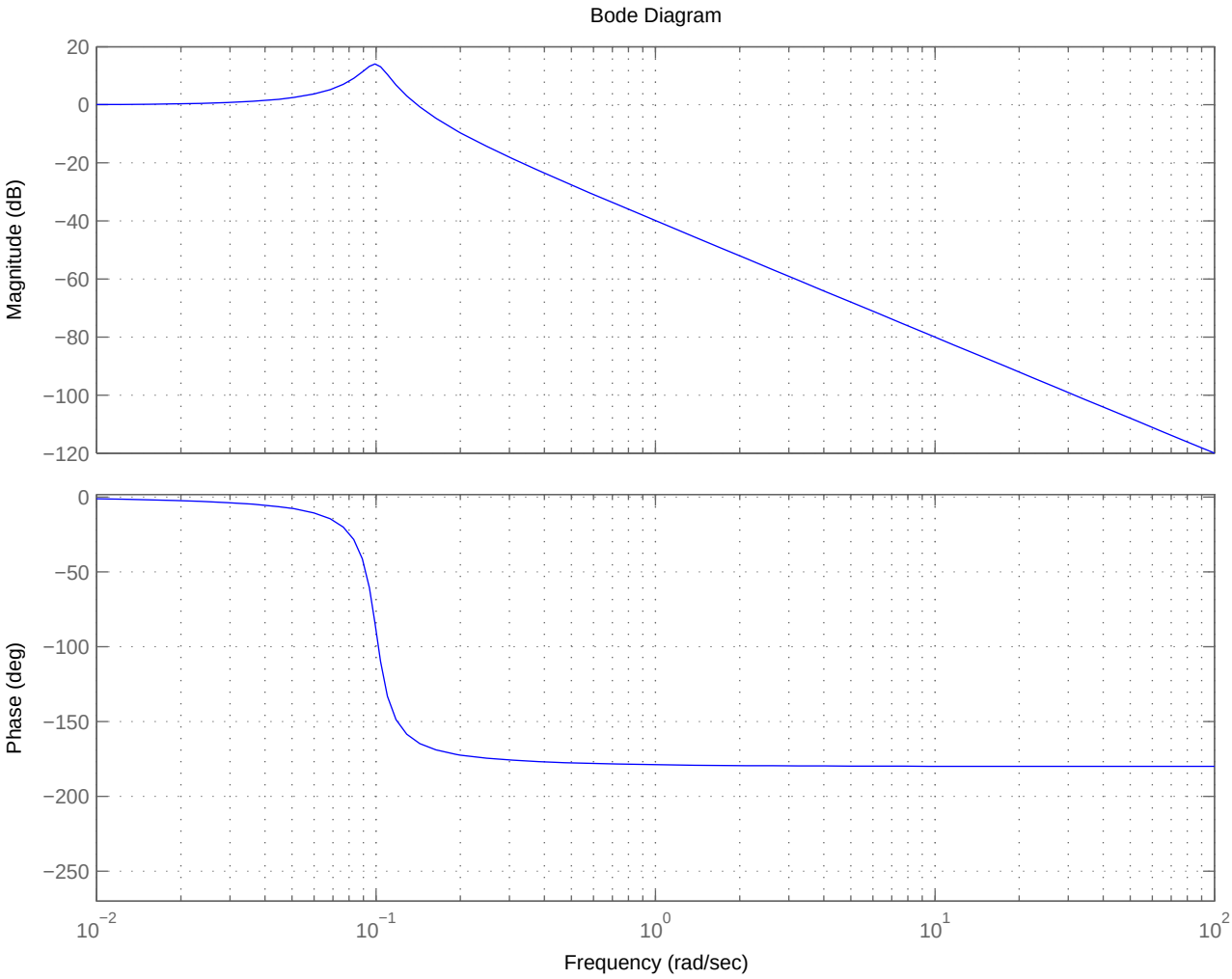

Figure 1: Bode plot for G_3.

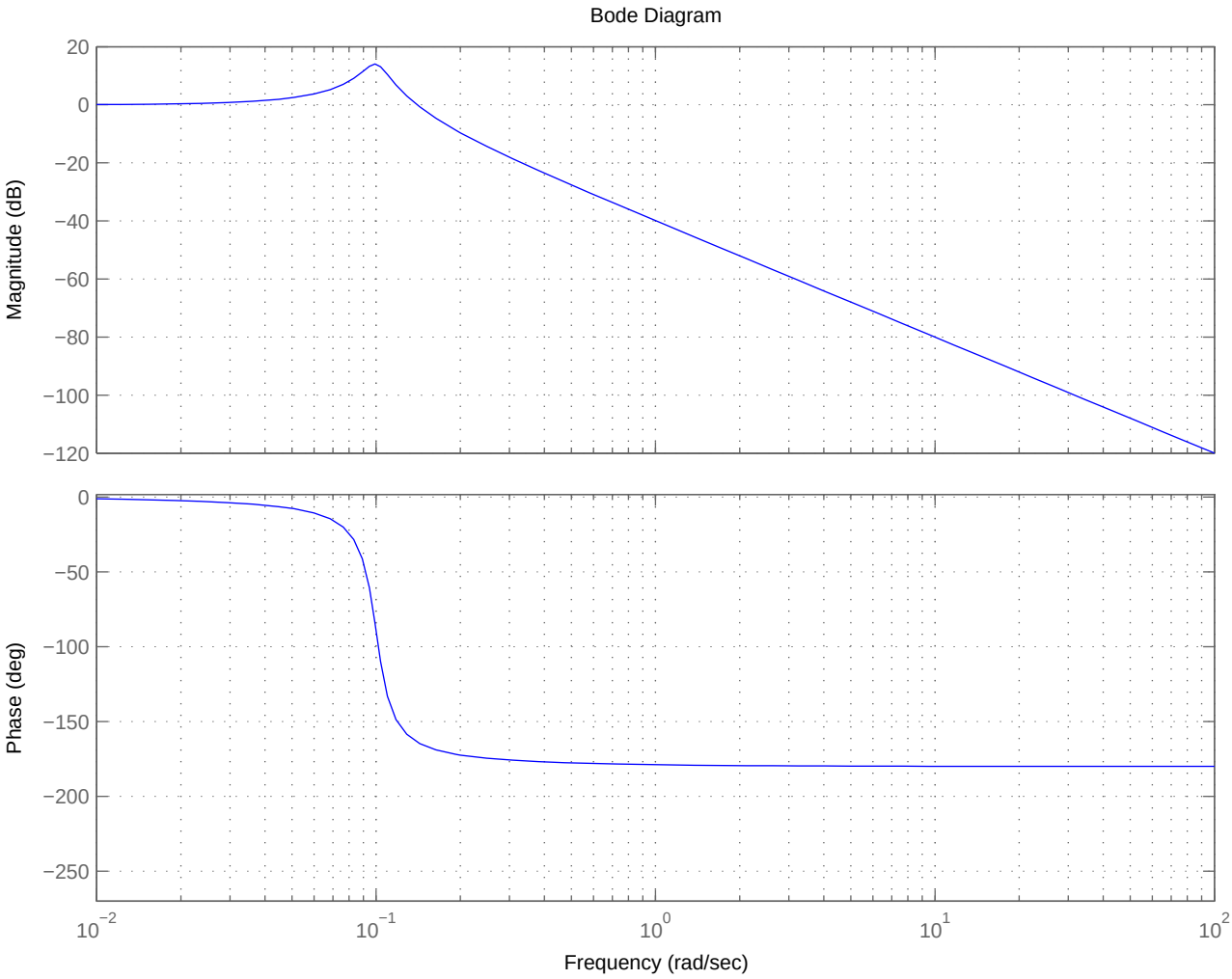

Figure 2: Bode plot for G_3: draw $G_1 \cdot G_3$.

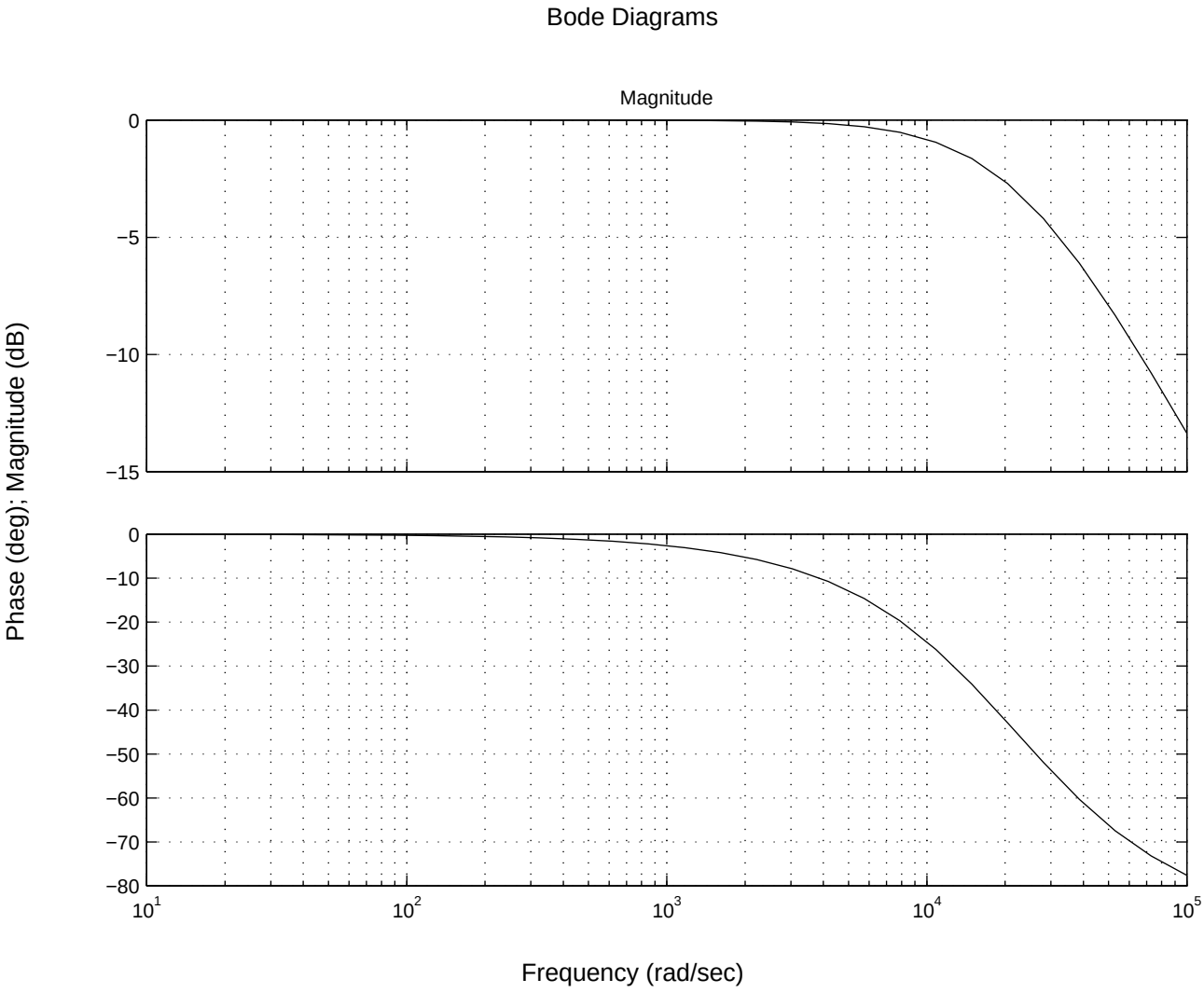

Figure 3: Bode plot for $H_1(s) = \frac{22000}{22000+s}$.

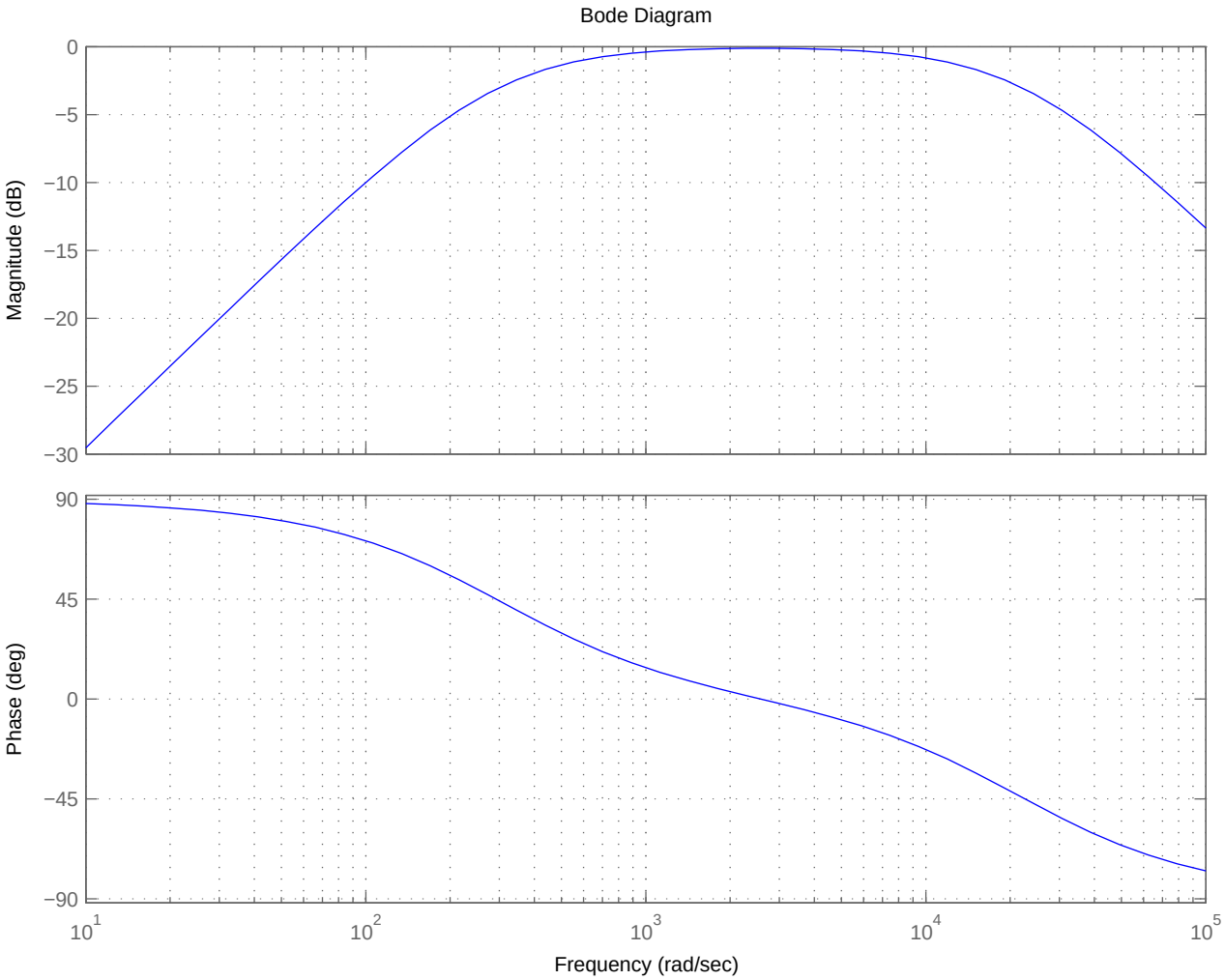

Figure 4: Bode plot for $H_2(s) = \frac{22000s}{(s+300)(22000+s)}$