A Design Study Approach to Classical Control

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Homework D.15

Draw by hand the Bode plot of the mass spring damper from force $\tilde{F}$ to position $\tilde{z}$. Use the `bode` command in Matlab or Python and compare your results.

Solution

From HW D.5, the transfer function for the mass spring damper is

$$P(s) = \frac{1/m}{s(s+b/m)} = \frac{0.2}{s(s+0.1)}. \tag{1}$$

In Bode canonical form we have

$$P(j\omega) = \frac{2}{(j\omega)(1+j\frac{\omega}{0.1})}$$

Therefore

$$20\log_{10}|P(j\omega)| = 20\log_{10} 2 - 20\log_{10}|j\omega| - 20\log_{10}\left|1+j\frac{\omega}{0.1}\right|.$$

Therefore, the Bode plot for magnitude will be the graphical addition of a constant gain, an integrator, and a pole. Similarly, the phase is given by

$$\angle P(j\omega) = \angle 2 - \angle(j\omega) - \angle(1+j\frac{\omega}{0.1}).$$

The straight line approximation as well as the Bode plot generated by Matlab are shown in Figure 1.

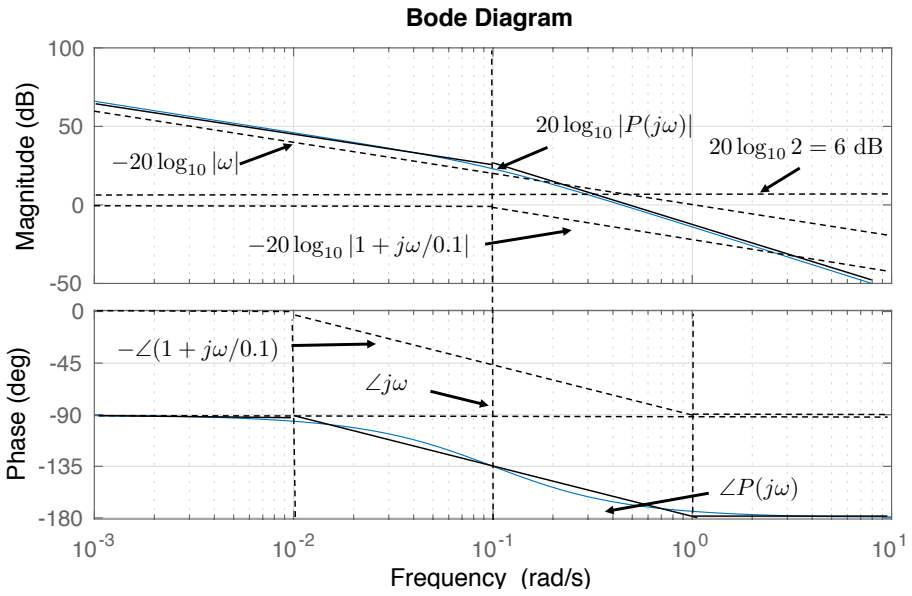

Figure 1: Bode plot for the transfer function given in Equation (1).

The Python command to generate the Bode plot is

```
>> import matplotlib.pyplot as plt
>> import control as cnt
>> P = tf([.2],[1, 0.1, 0]);
>> plt.figure(1), clf, cnt.bode_plot(P), grid on
```