1. **(30 Points)** Several studies have proposed an extravehicular robot that could move around in a NASA space station and perform physical tasks at various worksites. The arm is controlled by a unity-gain negative feedback control with open loop transfer function

$$L(s) = C(s)G(s) = \frac{k}{s(s/5+2)(s/100+1)}.$$

Sketch the Bode diagram for $K = 20$, and determine the frequency ω such that $|L(j\omega)|_{dB} = 0_{dB}$.

2. **(70 Points)** Consider the system $G(s) = \frac{1}{s^2}$**.** Design a controller that guarantees a settling time (with a 2% criterion) $T_s \leq 4\ sec$, and a percent overshoot for a step input $\leq 35\%$.

Remember that for a transfer function of the form $G(s) = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$, the following formulae hold:

$$t_r = \frac{\pi-\beta}{\omega_n\sqrt{1-\zeta^2}} \qquad t_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} \qquad M_p = e^{-\frac{\zeta}{\sqrt{1-\zeta^2}}\pi} \qquad T_s(2\%) = \frac{4}{\zeta\omega_n}$$

which provide the rise time, peak time, maximum overshoot, and settling time, respectively, and β is such that $\cos(\beta) = \zeta$

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