What is the correct gain and phase of the output?

$$\frac{dy}{dy} + 4y = 2\sin 3t \quad \Rightarrow \quad y = A\sin(3t + \varphi) + Be^{-4t}$$

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For each pair below, find the gain and phase of G(jw) in terms of w and hence find the asymptotic value of y(t) when Y(s)=G(s)U(s).

$$G(s) = \frac{8}{s+7} \qquad G(s) = \frac{1+2s}{s+2} \qquad G(s) = \frac{4}{s+0.3} \qquad G(s) = \frac{3}{(s+2)(s+5)}$$

$$u = \sin(6t) \qquad u = \sin(4t) \qquad u(t) = \cos(0.1\sqrt{3}\,t) \qquad u(t) = \sin(2t)$$

Find the gain and phase of the following transfer functions.

$$G(s) = \frac{(s+2)}{(s+3)}; \quad G(s) = \frac{(s+2)}{(s+3)(s+4)}; \quad G(s) = \frac{(s+1)(s+2)}{(s+3)(s+4)}; \quad G(s) = \frac{4}{s(s+4)}$$

$$G = \frac{5}{s - 2\sqrt{3}}; \quad G = \frac{1-s}{s+3}; \quad G = \frac{3-s}{s(s^2-1)}$$

Sketch the Bode diagrams, and hence the Nyquist diagrams, for the following systems.

$$G(s) = \frac{(s+2)}{(s+3)}; \quad G(s) = \frac{(s+2)}{(s+3)(s+4)}; \quad G(s) = \frac{(s+20)}{(s+3)^2(s+4)}; \quad G(s) = \frac{4}{s(s+4)}$$

$$G = \frac{5}{s - 2\sqrt{3}}; \quad G = \frac{1-s}{s+3}; \quad G = \frac{3-s}{s(s^2-1)}; \quad G(s) = \frac{s+2}{s(s+1)^2(s+5)}; \quad G(s) = \frac{s+20}{s(s+1)^2(s+5)}$$

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1. How do you interpret the information in the Bode plots ?
2. What is frequency response?
3. How do you do a quick sketch of the bode plots?
4. Where do the sketches need to be accurate?
5. Why do gain plots always go to zero as frequency increases?
6. Why does phase lag tend to increase with frequency?
7. Can you compute asymptotes reliably? Do you understand how the asymptotes are derived?
8. Would you be comfortable sketching a Bode plot within just a few minutes.
9. Extract data from the Bode plot to evaluate the output response at a given frequency.

Give an explanation of resonance and illustrate with 3 examples. Include the Bode diagrams.

$$\frac{1}{s^2+2s+2}; \quad \frac{1}{s^2+s+2}; \quad \frac{1}{s^2+0.2s+2}$$

Give an explanation of how dead-time affects Bode and Nyquist diagrams. Illustrate with several examples.

Give an explanation of bandwidth and illustrate with 3 examples of your choice. Include the Bode diagrams.

Sketch, using asymptotes, the Bode diagrams of the following transfer functions and verify them in MATLAB. How would the Bode plots change if G were modified as G → GK where K=(s+1)/(s+5) and K=(s+5)/(s+1):

$$\frac{100}{s+5}; \quad \frac{20}{s+3}; \quad \frac{10}{(s+1)(s+2)}; \quad \frac{100}{(s+3)(s+4)};$$

$$\frac{10}{s(s+1)(s+2)}; \quad \frac{0.4}{s(s+2)(s+5)}; \quad \frac{0.2(s+1)}{(s+2)(s+3)}; \quad \frac{5(s+2)(s+1)}{s^2(s+3)};$$

Common compensators (Lead and Lag) take the form below. Plot the bode gain and phase plots for K=1, a=1 and r=10 for each of these. What do you notice that is different about them?

$$K(s) = K\frac{s+a}{s+ra}; \quad r>1 \qquad K(s) = K\frac{s+ra}{s+a}; \quad r>1 \qquad G(s) = \frac{5}{s(s+2)^2}$$

- Sketch the Bode diagrams for other lead and lag compensators of your choice and explain the key attributes of each and how these might be used for design.
- By sketching the relevant Bode and Nyquist diagrams, demonstrate the effect of the lead and lag compensators above on a system G(s).
- What is a lead-lag compensator. Sketch the Bode diagram for one of these and explain the key attributes and how these might be used for design.

Sketch the Bode gain and phase asymptotes for the following system.

$$G(s) = 0.26\frac{3(s+9)}{s(s+2)(s+4)}$$

By computing some exact values of $G(jw)$ at appropriate frequencies, improve your estimates of the Bode plots and hence improve your sketch. How did you choose your frequencies?

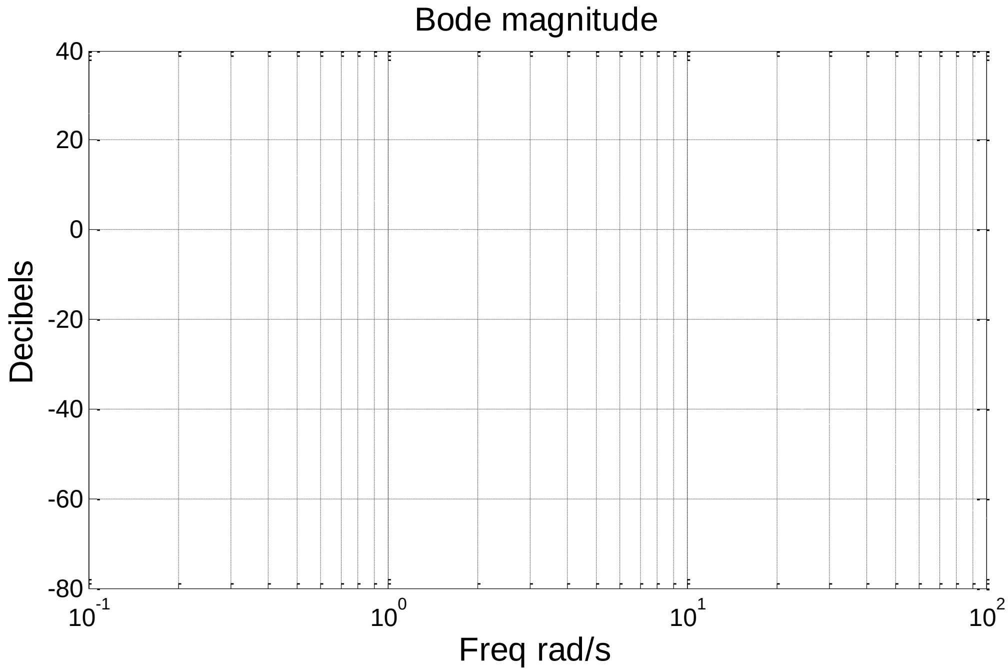
After first giving a clear definition of the gain and phase margins, show how you can use the Bode plots to estimate the gain and phase margins for $G(s)$. Mark the margins clearly on the Bode plots.

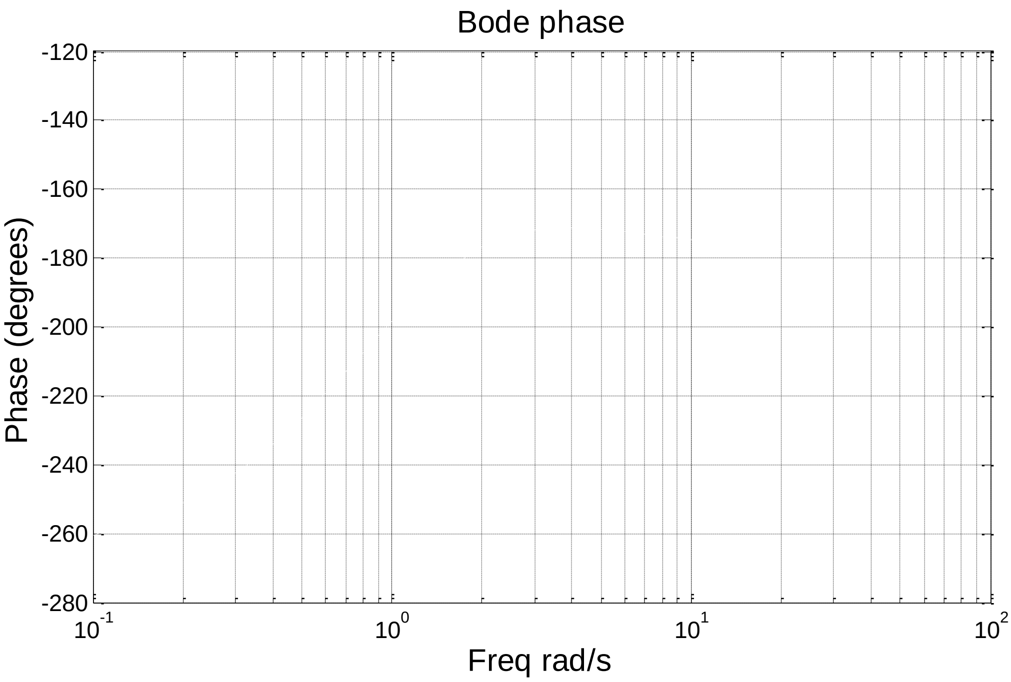
A lag compensator $K(s)$ is used to improve the margins. Comment on the new margins.

$$K(s) = 0.26\frac{(s+0.09)}{(s+0.02)}$$

Form the Bode diagrams for G with and without the compensators and hence compare the margins with and without compensation and also with a proportional compensator of K=4.

$$G(s)=\frac{6(s+1)}{s(s-1)(s+3)};\quad K_1=\frac{4(s+2)}{s+5};\quad K_2=\frac{4(s+0.1)}{(s+0.04)}$$

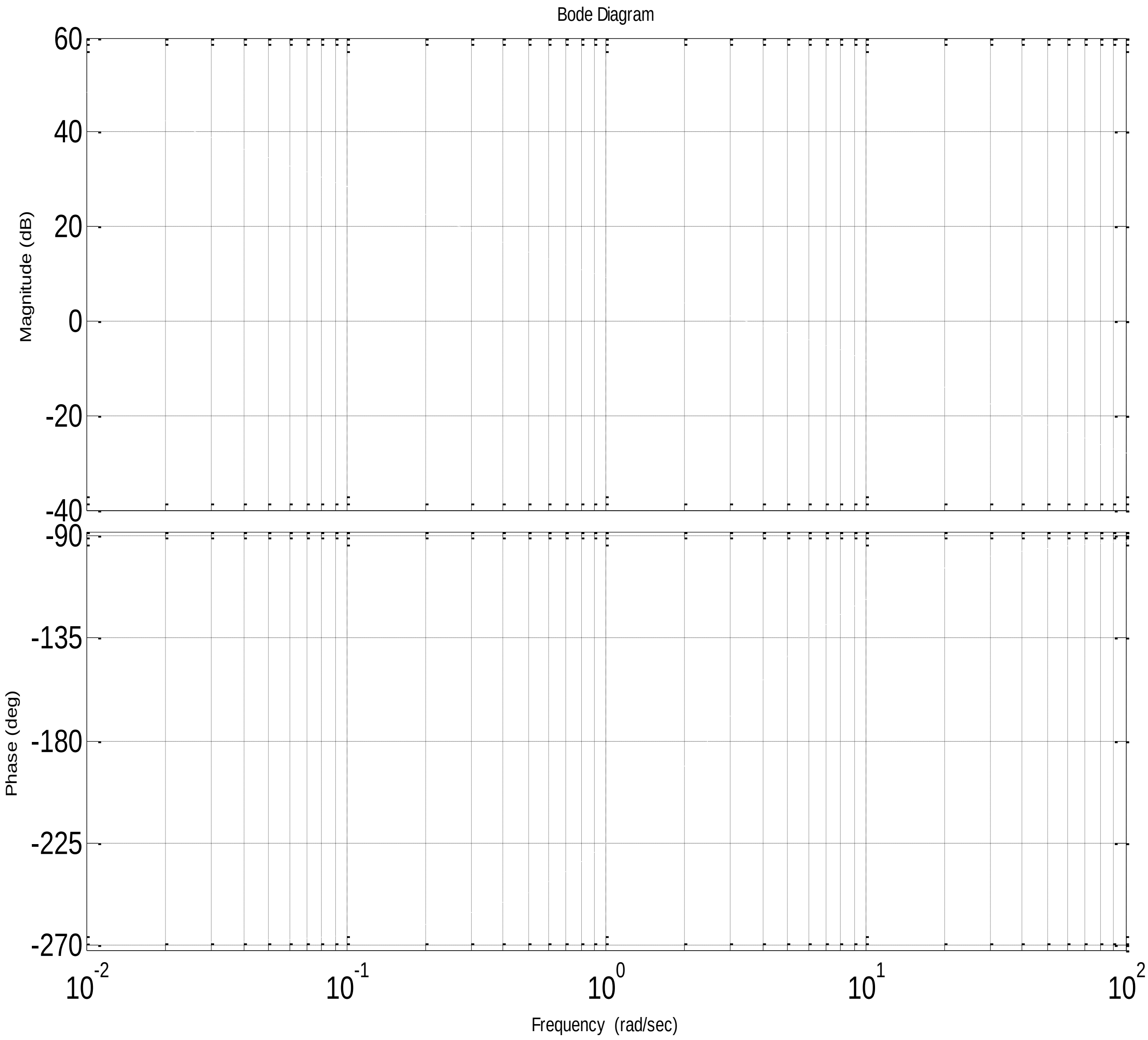




You are given a system G(s). $G(s) = \dfrac{4(s+2)}{s(s-3)}$

Sketch the Bode diagram with each of the following compensators. [Check answers with MATLAB]

$$K(s) = 0.2; \quad K(s) = 3; \quad K(s) = \frac{2(s+2)}{s+4}$$



Sketch the Bode asymptotes and hence a more accurate Bode diagram for

$$G(s) = \frac{10^{-3}(s+4)}{s(s+2)(s+0.1)^2}\,.$$

Use this Bode diagram to estimate the gain and phase margins, giving all your working and definitions clearly.