Bode Plot Examples

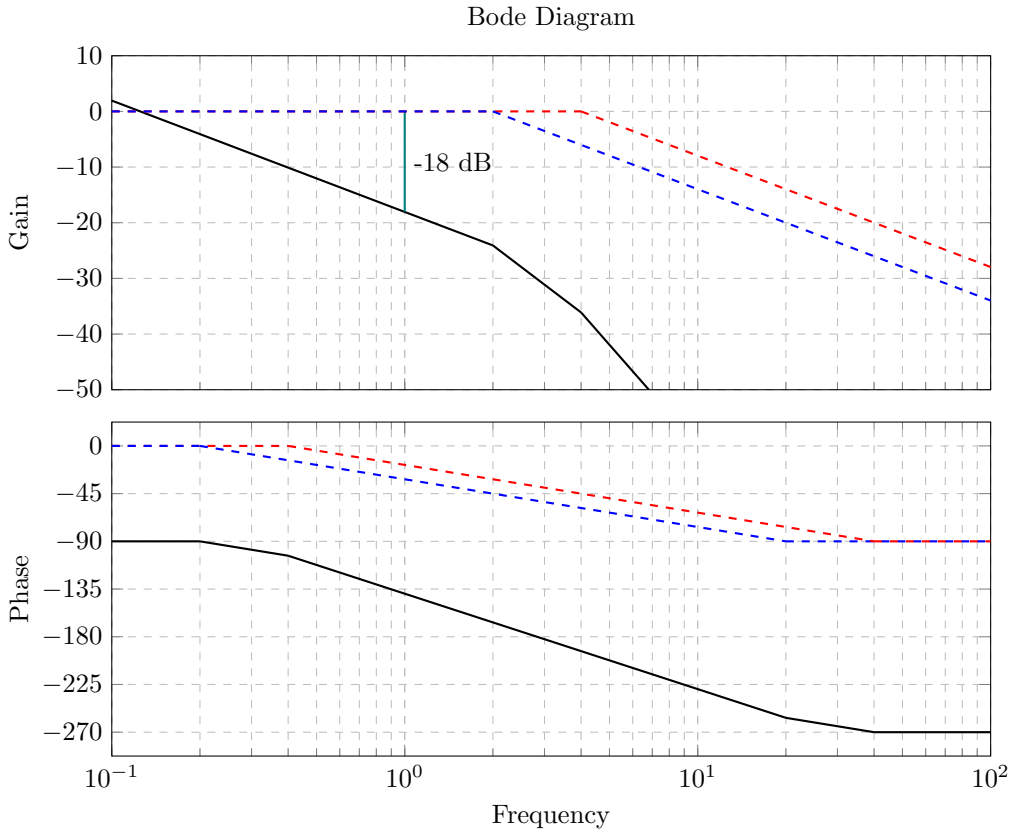
Dashed lines show the individual asymptotes. Add these together (and account for the magnitude of the gain and the starting slope/phase due to any integrators) to get the complete sketch.

1. Draw the Bode asymptote plot for

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

Solution:

- 1 integrator, so start with -20dB/dec slope with 0dB at $\omega = 1$ rad/s and $-90°$ phase.
- $K = \dfrac{1}{2 \cdot 4} = -18$ dB, so shift by -18dB (no change to phase plot).
- Pole at $s = -2$ (blue) add -20dbB/dec at $\omega = 2$, and a $-90°$ shift from $\omega = 0.2$ to $\omega = 20$. (Or, adds $-45°$/dec at $\omega = 0.2$ and $+45°$/dec at $\omega = 20$.)
- Pole at $s = -4$ (red) add -20dbB/dec at $\omega = 4$, and a $-90°$ shift from $\omega = 0.4$ to $\omega = 40$. (Or, adds $-45°$/dec at $\omega = 0.4$ and $+45°$/dec at $\omega = 40$.)

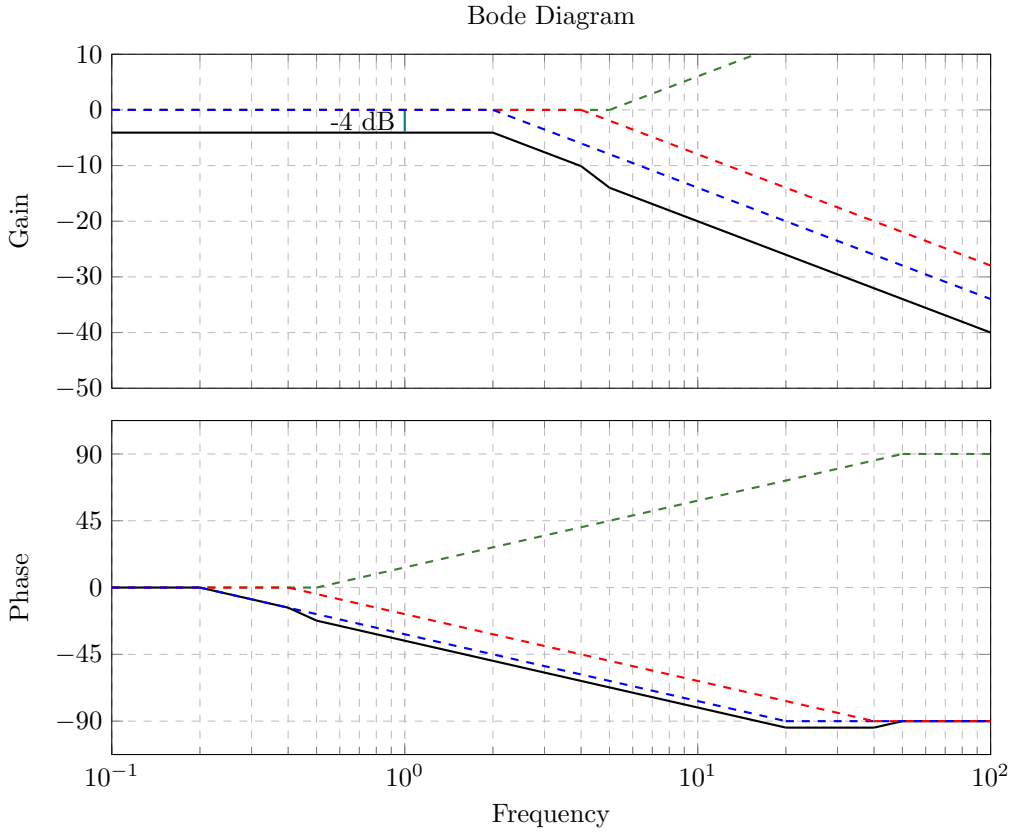


2. Draw the Bode asymptote plot for

$$G(s) = \frac{(s+5)}{(s+2)(s+4)}$$

Solution:

- No integrators, so start with a flat line on 0dB and 0° phase.
- $K = \frac{5}{2 \cdot 4} = -4$ dB, so shift by -4dB (no change to phase plot).
- Pole at $s = -2$ (blue) add -20dbB/dec at $\omega = 2$, and a $-90°$ shift from $\omega = 0.2$ to $\omega = 20$. (Or, adds $-45°$/dec at $\omega = 0.2$ and $+45°$/dec at $\omega = 20$.)
- Pole at $s = -4$ (red) add -20dbB/dec at $\omega = 4$, and a $-90°$ shift from $\omega = 0.4$ to $\omega = 40$. (Or, adds $-45°$/dec at $\omega = 0.4$ and $+45°$/dec at $\omega = 40$.)
- Zero at $s = -5$ (green) add $+20$dbB/dec at $\omega = 5$, and a $+90°$ shift from $\omega = 0.5$ to $\omega = 50$. (Or, adds $+45°$/dec at $\omega = 0.5$ and $-45°$/dec at $\omega = 50$.)

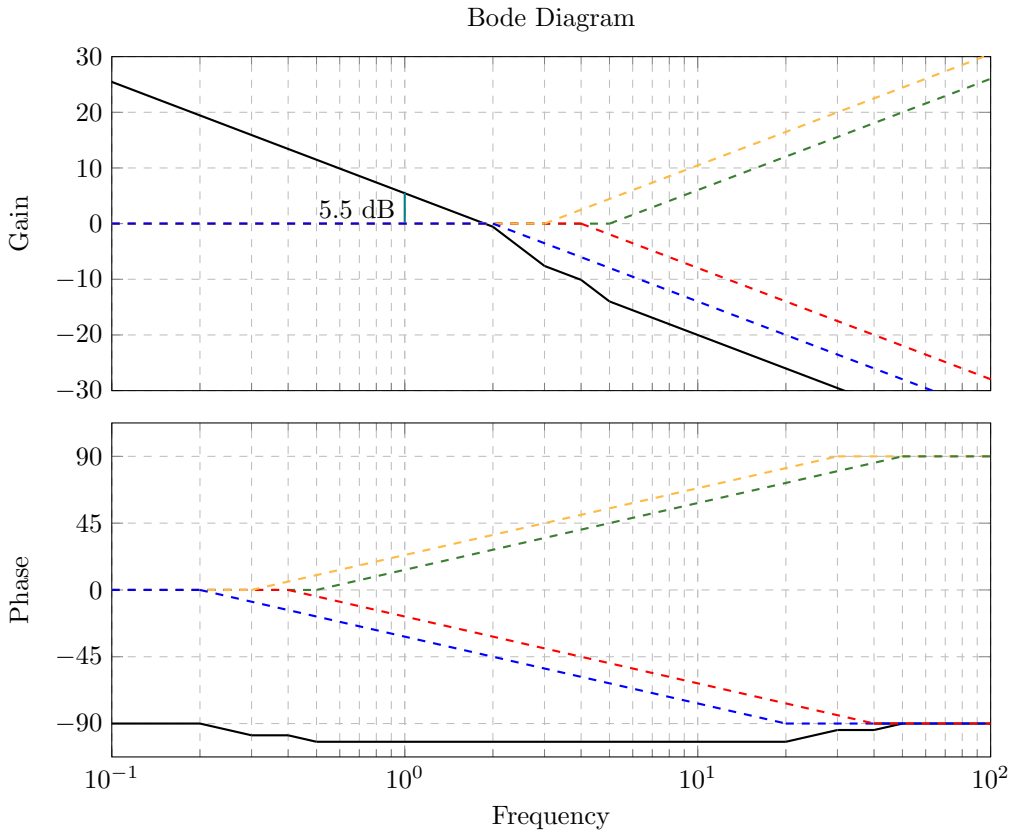


3. Draw the Bode asymptote plot for

$$G(s) = \frac{(s+3)(s+5)}{s(s+2)(s+4)}$$

Solution:

- No integrators, so start with a flat line on 0dB and 0° phase.
- $K = \frac{5}{2 \cdot 4} = -4$ dB, so shift by -4dB (no change to phase plot).
- Pole at $s = -2$ (blue) add -20dbB/dec at $\omega = 2$, and a $-90°$ shift from $\omega = 0.2$ to $\omega = 20$. (Or, adds $-45°$/dec at $\omega = 0.2$ and $+45°$/dec at $\omega = 20$.)
- Zero at $s = -3$ (yellow) add $+20$dbB/dec at $\omega = 3$, and a $+90°$ shift from $\omega = 0.3$ to $\omega = 30$. (Or, adds $+45°$/dec at $\omega = 0.3$ and $-45°$/dec at $\omega = 30$.)
- Pole at $s = -4$ (red) add -20dbB/dec at $\omega = 4$, and a $-90°$ shift from $\omega = 0.4$ to $\omega = 40$. (Or, adds $-45°$/dec at $\omega = 0.4$ and $+45°$/dec at $\omega = 40$.)
- Zero at $s = -5$ (green) add $+20$dbB/dec at $\omega = 5$, and a $+90°$ shift from $\omega = 0.5$ to $\omega = 50$. (Or, adds $+45°$/dec at $\omega = 0.5$ and $-45°$/dec at $\omega = 50$.)

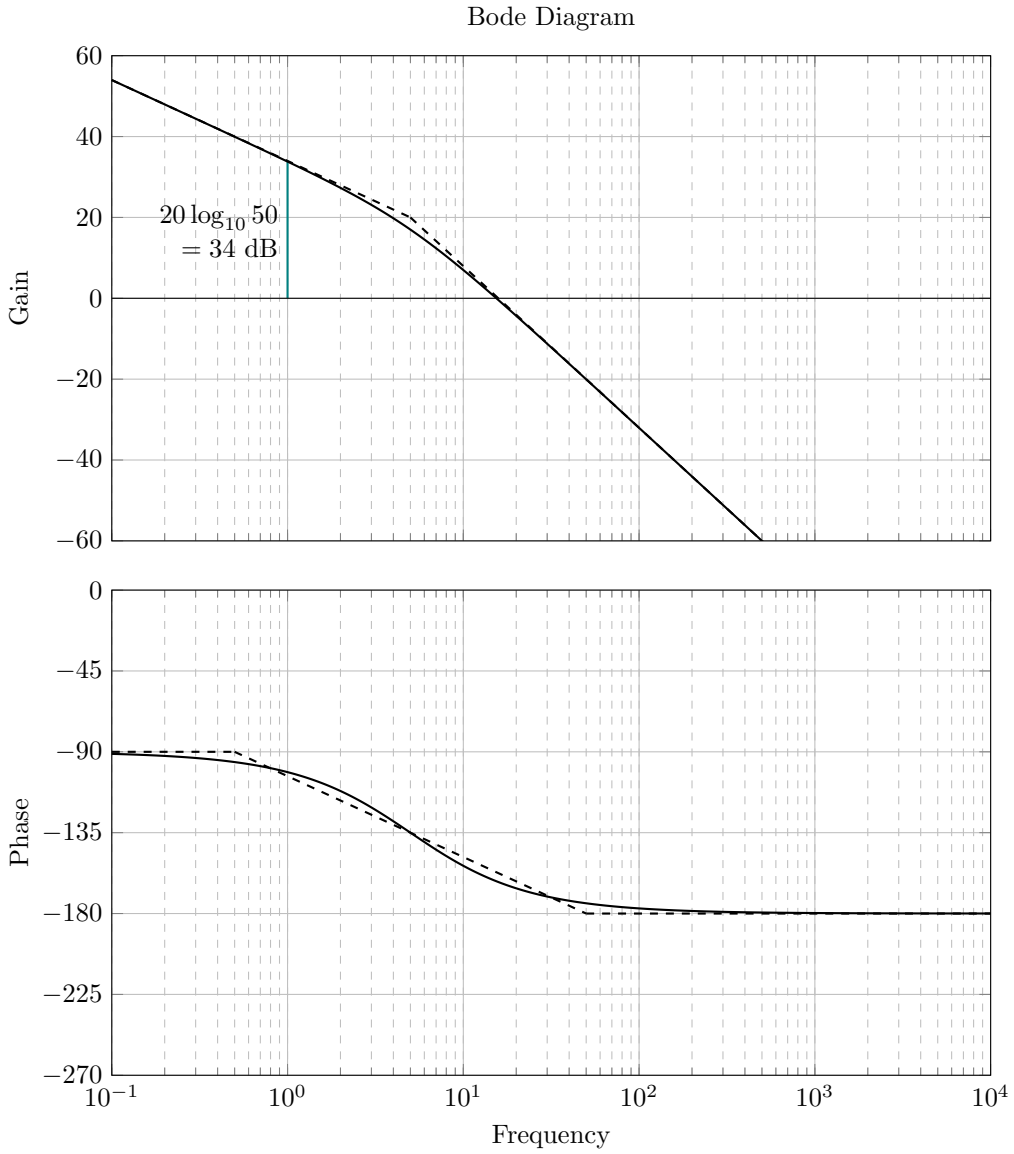


4. Draw the Bode asymptote plot for

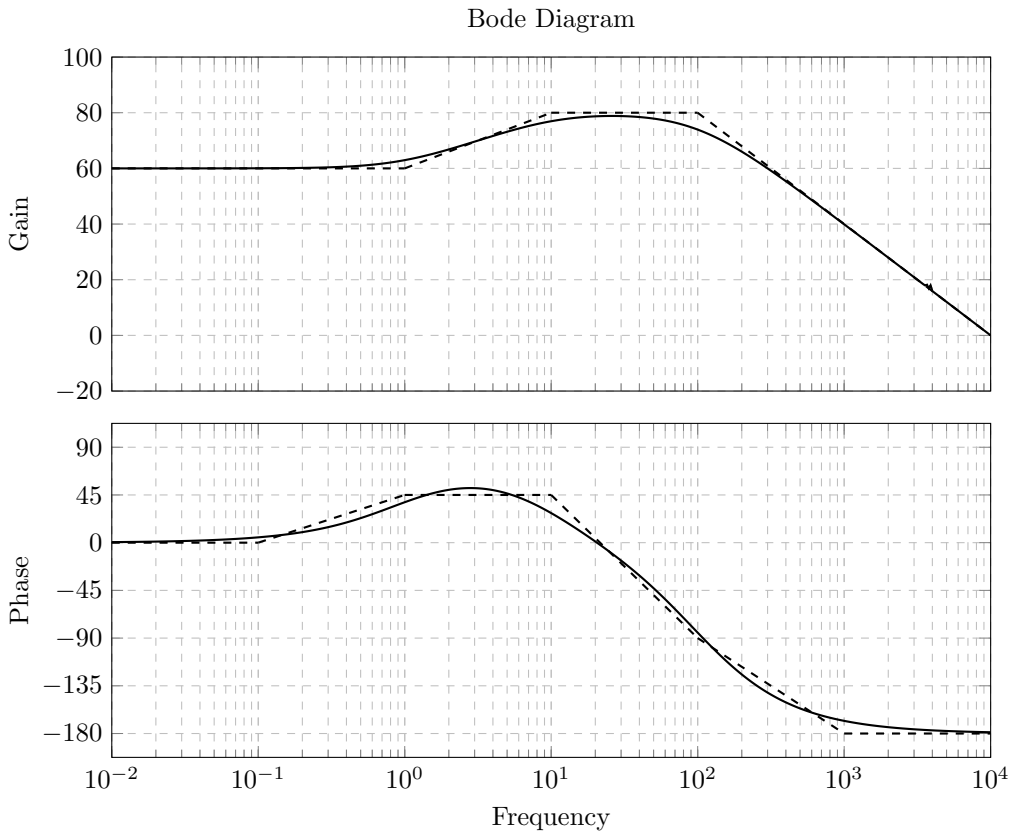
$$G(s) = \frac{50}{s(0.2s+1)}$$

Solution:

- 1 integrator, so start with -20dB/dec slope with 0dB at $\omega = 1$ rad/s and -90° phase.
- $K = 50 = 34$ dB, so shift by 34dB (no change to phase plot).
- Pole at $s = -5$ (blue) add -20dbB/dec at $\omega = 5$, and a -90° shift from $\omega = 0.5$ to $\omega = 50$. (Or, adds -45°/dec at $\omega = 0.5$ and $+45^\circ$/dec at $\omega = 50$.)



5. For the Bode diagram below, determine the transfer function.



- 60dB magnitude as $s \to 0$: $K = 60dB = 1000$.
- +20dB/dec slope at $\omega = 1$; +45°/dec phase centered on $\omega = 1$. Therefore, there is a zero at $\omega = 1$.
- –20dB/dec slope at $\omega = 10$; –45°/dec phase centered on $\omega = 10$. Therefore, there is a pole at $\omega = 10$.
- –40dB/dec slope at $\omega = 100$; –90°/dec phase centered on $\omega = 100$ and over 2 decades. Therefore, there are two poles at $\omega = 100$.

$$\Rightarrow L(s) = \frac{1000\,(s+1)}{\left(\frac{s}{10}+1\right)\left(\frac{s}{100}+1\right)^2}$$