

Bode Plots

(more examples)

Example

$$G(s) = \left(\frac{s}{\omega_n}\right)^2 + 2\zeta\frac{s}{\omega_n} + 1 \quad (\omega_n, \zeta \text{ positive})$$

$$20 \log_{10} |G(j\omega)| = 20 \log_{10} \left| \left(\frac{j\omega}{\omega_n}\right)^2 + 2\zeta\frac{j\omega}{\omega_n} + 1 \right|$$

$$\text{At low frequency} = 20 \log_{10} |1| =$$

$$\text{At high frequency} = 20 \log_{10} \left| \left(\frac{j\omega}{\omega_n}\right)^2 \right| =$$

Two lines meet at $\omega = \omega_n$ (break point)

Example

$$G(s) = \left(\frac{s}{\omega_n}\right)^2 + 2\zeta\frac{s}{\omega_n} + 1 \quad (\omega_n, \zeta \text{ positive})$$

$$\angle G(j\omega) = \angle\left(\left(\frac{j\omega}{\omega_n}\right)^2 + 2\zeta\frac{j\omega}{\omega_n} + 1\right)$$

$$\text{At low frequency} = \angle 1 =$$

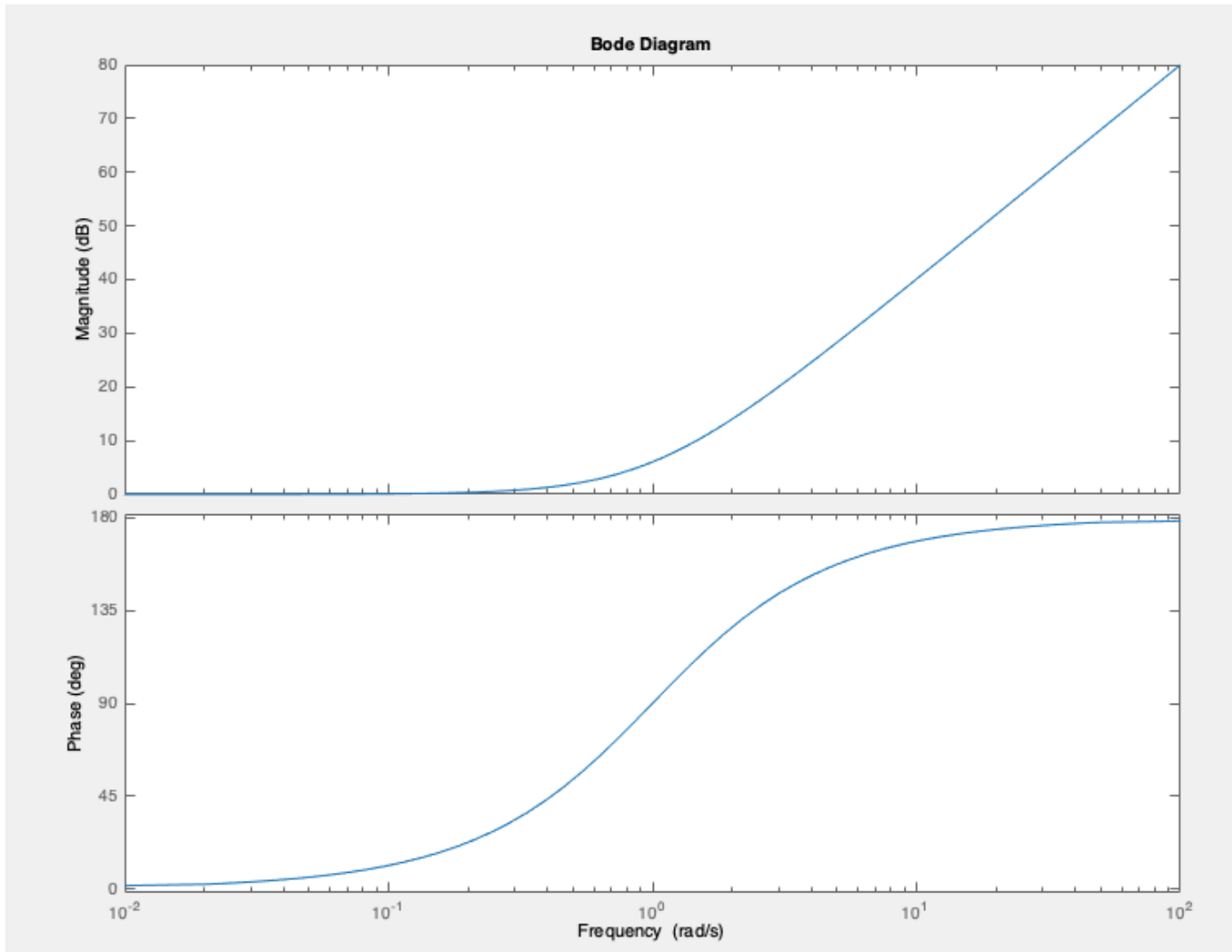
$$\text{At high frequency} = \angle\left(\frac{j\omega}{\omega_n}\right)^2 =$$

$$\text{At frequency } (\omega \approx \omega_n) = \angle((j)^2 + 2\zeta j + 1) =$$

Two lines are connected by a third line at $\omega = \frac{\omega_n}{10^\zeta}$ and $\omega = 10^\zeta\omega_n$

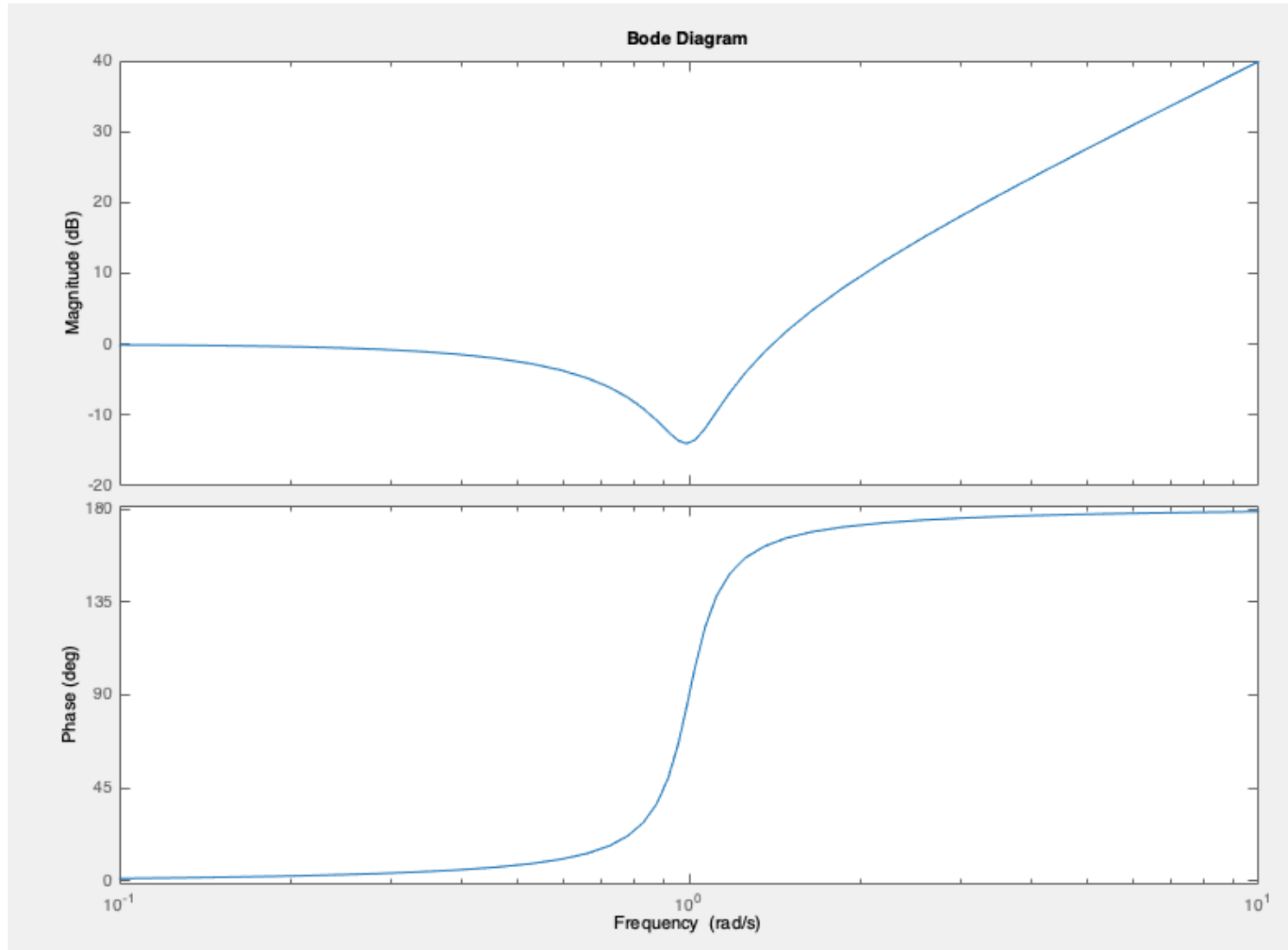
Example

$$G(s) = s^2 + 2s + 1 \quad (\omega_n = 1, \zeta = 1)$$



Example

$$G(s) = s^2 + 0.2s + 1 \quad (\omega_n = 1, \zeta = 0.1)$$



Example

$$G(s) = \frac{1}{(\frac{s}{\omega_n})^2 + 2\zeta \frac{s}{\omega_n} + 1} \quad (\omega_n, \zeta \text{ positive})$$

$$20 \log_{10} |G(j\omega)| = 20 \log_{10} \left| \frac{1}{(\frac{j\omega}{\omega_n})^2 + 2\zeta \frac{j\omega}{\omega_n} + 1} \right|$$

$$\text{At low frequency} = 20 \log_{10} \left| \frac{1}{1} \right| =$$

$$\text{At high frequency} = 20 \log_{10} \left| \frac{1}{(\frac{j\omega}{\omega_n})^2} \right| =$$

Two lines meet at $\omega = \omega_n$ (break point)

Example

$$G(s) = \frac{1}{\left(\frac{s}{\omega_n}\right)^2 + 2\zeta \frac{s}{\omega_n} + 1} \quad (\omega_n, \zeta \text{ positive})$$

$$\angle G(j\omega) = \angle \frac{1}{\left(\frac{j\omega}{\omega_n}\right)^2 + 2\zeta \frac{j\omega}{\omega_n} + 1}$$

$$\text{At low frequency} = \angle \frac{1}{1} =$$

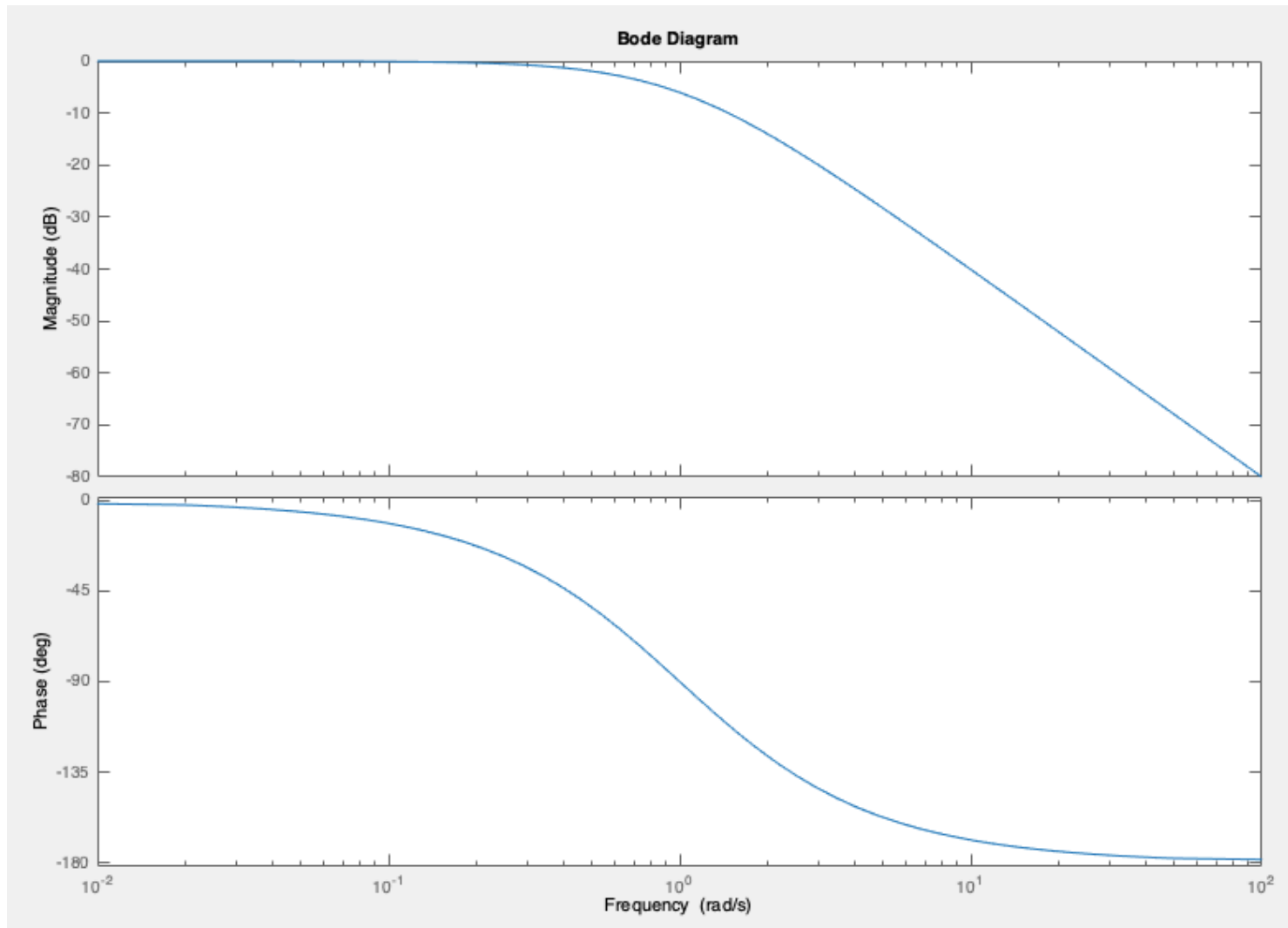
$$\text{At high frequency} = \angle \frac{1}{\left(\frac{j\omega}{\omega_n}\right)^2} =$$

$$\text{At frequency } (\omega \approx \omega_n) = \angle \frac{1}{(j)^2 + 2\zeta j + 1} =$$

Two lines are connected by a third line at $\omega = \frac{\omega_n}{10^\zeta}$ and $\omega = 10^\zeta \omega_n$

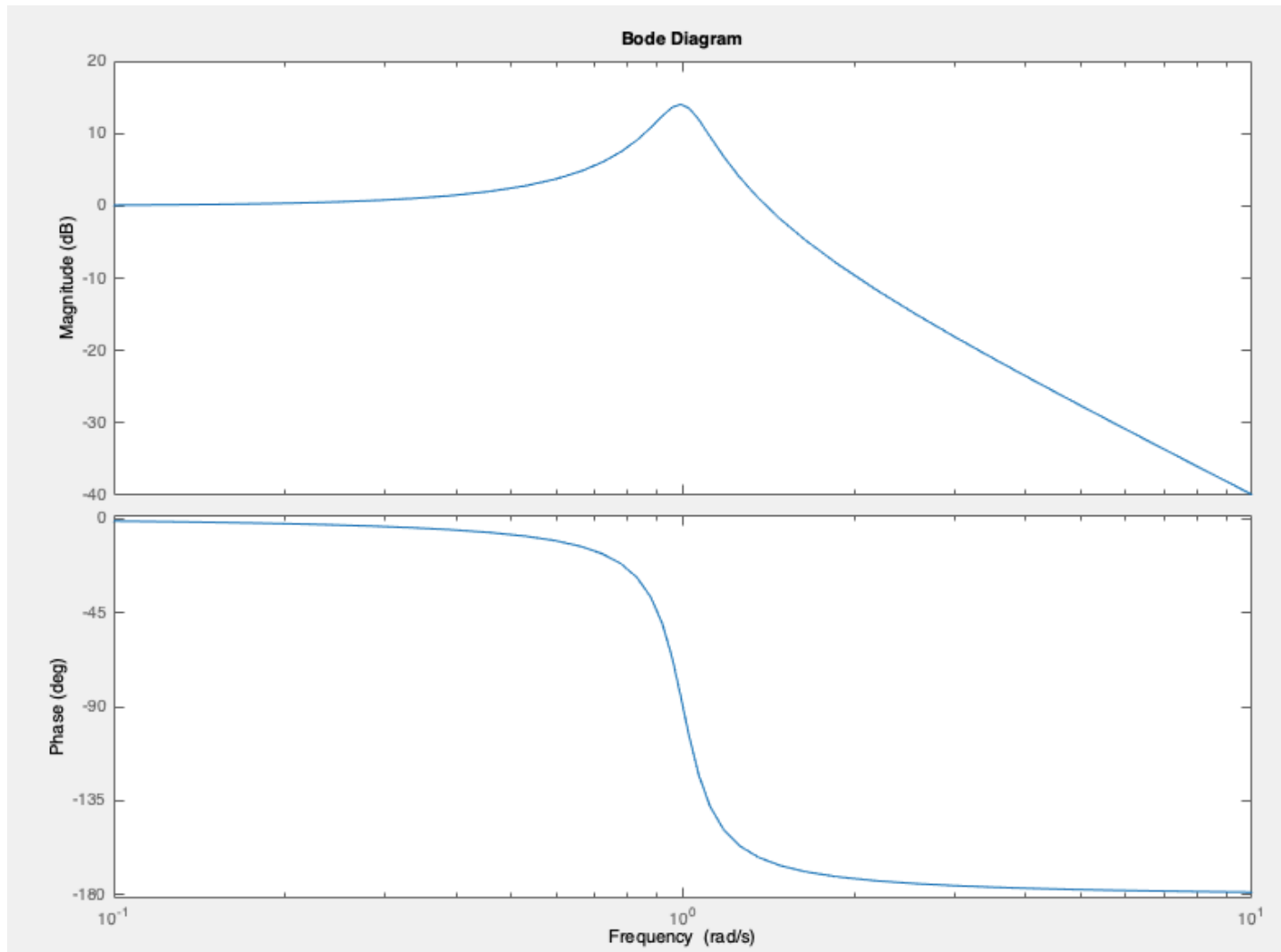
Example

$$G(s) = \frac{1}{s^2 + 2s + 1} \quad (\omega_n = 1, \zeta = 1)$$



Example

$$G(s) = \frac{1}{s^2 + 0.2s + 1} \quad (\omega_n = 1, \zeta = 0.1)$$



Example

$$G(s) = \frac{40s^2(s-2)}{(s-5)(s^2+4s+100)}$$

$$20 \log_{10} |G(j\omega)| =$$

Example

$$G(s) = \frac{40s^2(s-2)}{(s-5)(s^2+4s+100)} = \frac{(4/25)s^2(0.5s-1)}{(0.2s-1)((s/10)^2+2(1/5)(s/10)+1)}$$

$$\angle G(jw) =$$

Example

$$G(s) = \frac{40s^2(s-2)}{(s-5)(s^2+4s+100)} = \frac{(4/25)s^2(0.5s-1)}{(0.2s-1)((s/10)^2+2(1/5)(s/10)+1)}$$

