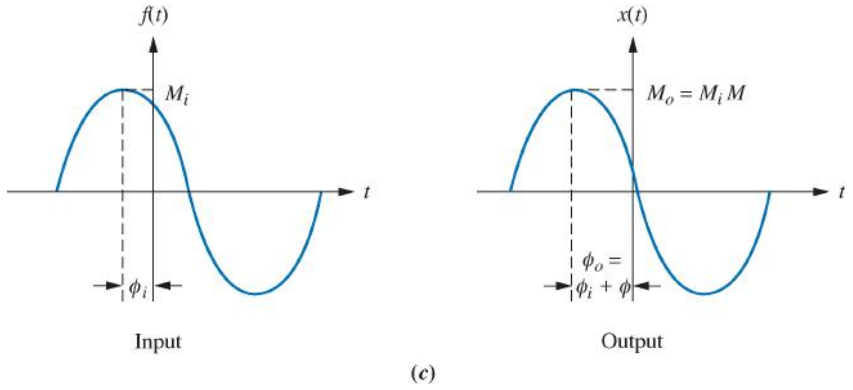
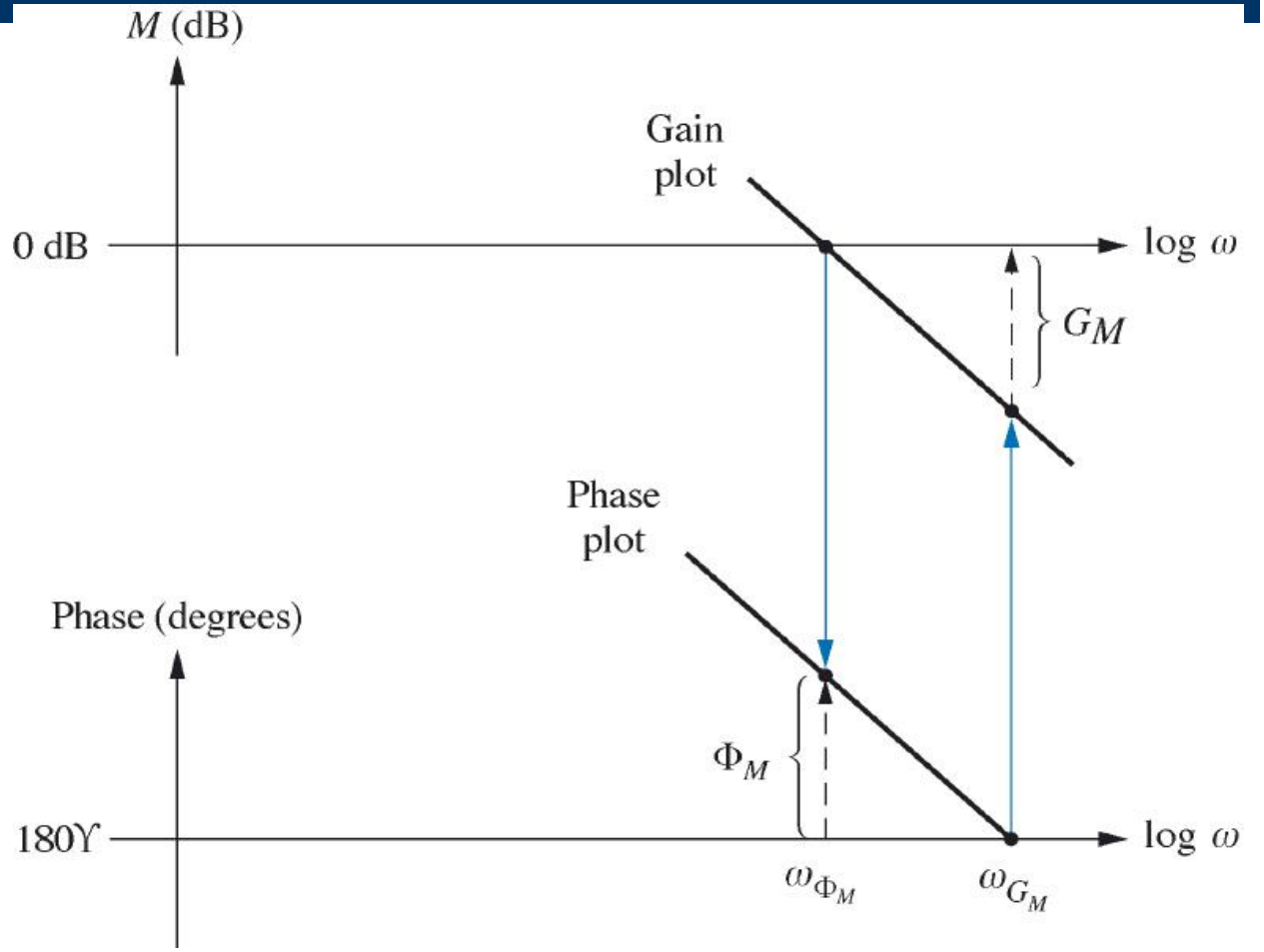
Frequency Response Techniques



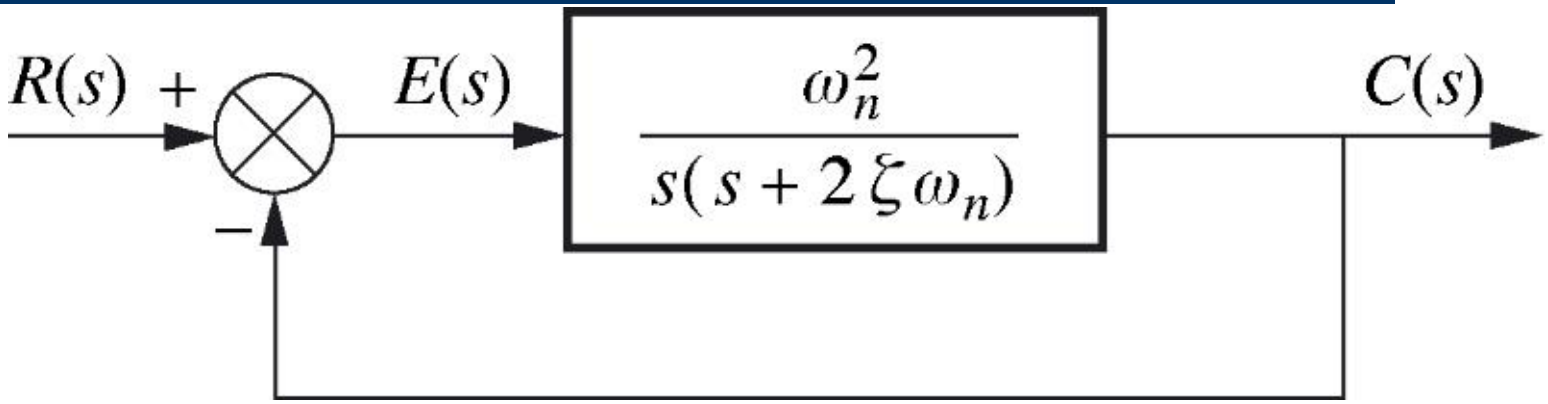
(c)

System & Control Engineering Lab.
School of Mechanical Engineering

Stability, Gain margin, Phase margin via Bode Plots



Relation between Closed-loop Transient and Closed –loop Frequency Responses



the closed-loop transfer function,

$$\frac{C(s)}{R(s)} = T(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

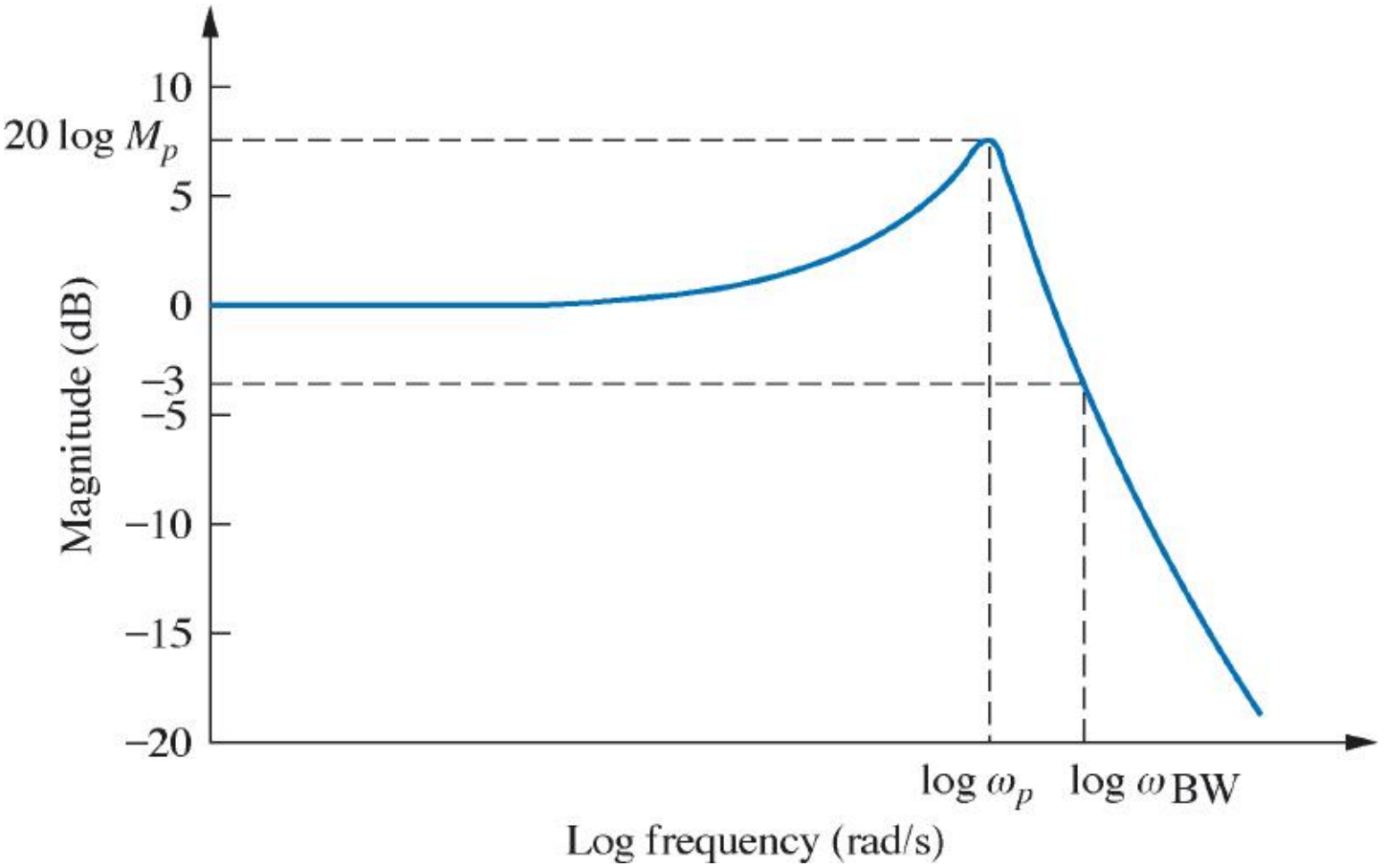
Relation between Closed-loop Transient and Closed –loop Frequency Responses

$$M = |T(j\omega)| = \frac{\omega_n^2}{\sqrt{\left(\omega_n^2 - \omega^2\right)^2 + 4\zeta^2\omega_n^2\omega^2}}$$

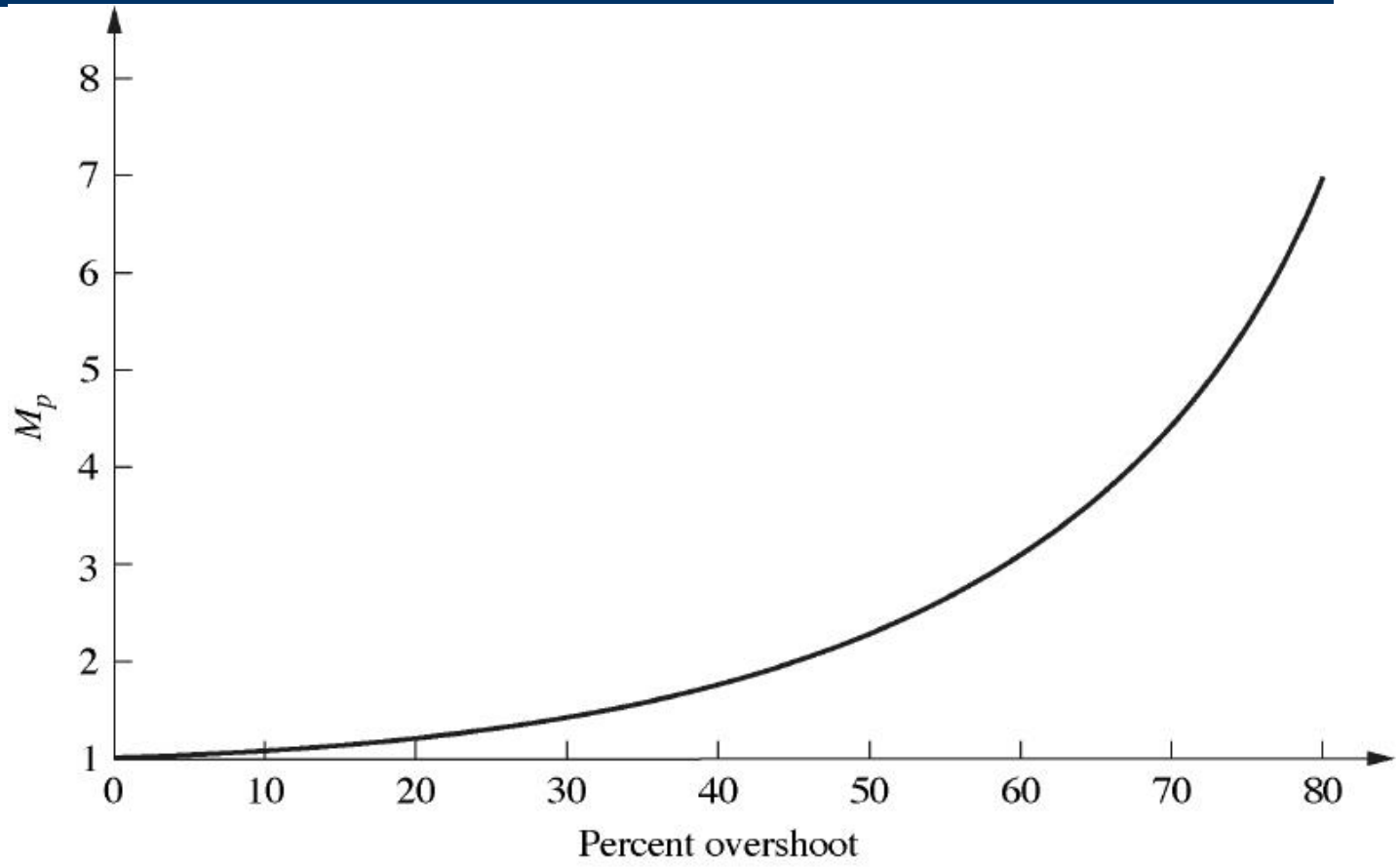
$$M_p = \frac{1}{2\zeta\sqrt{1-\zeta^2}}$$

$$\omega_p = \omega_n\sqrt{1-2\zeta^2}$$

Relation between Closed-loop Transient and Closed –loop Frequency Responses



Relation between Closed-loop Transient and Closed –loop Frequency Responses



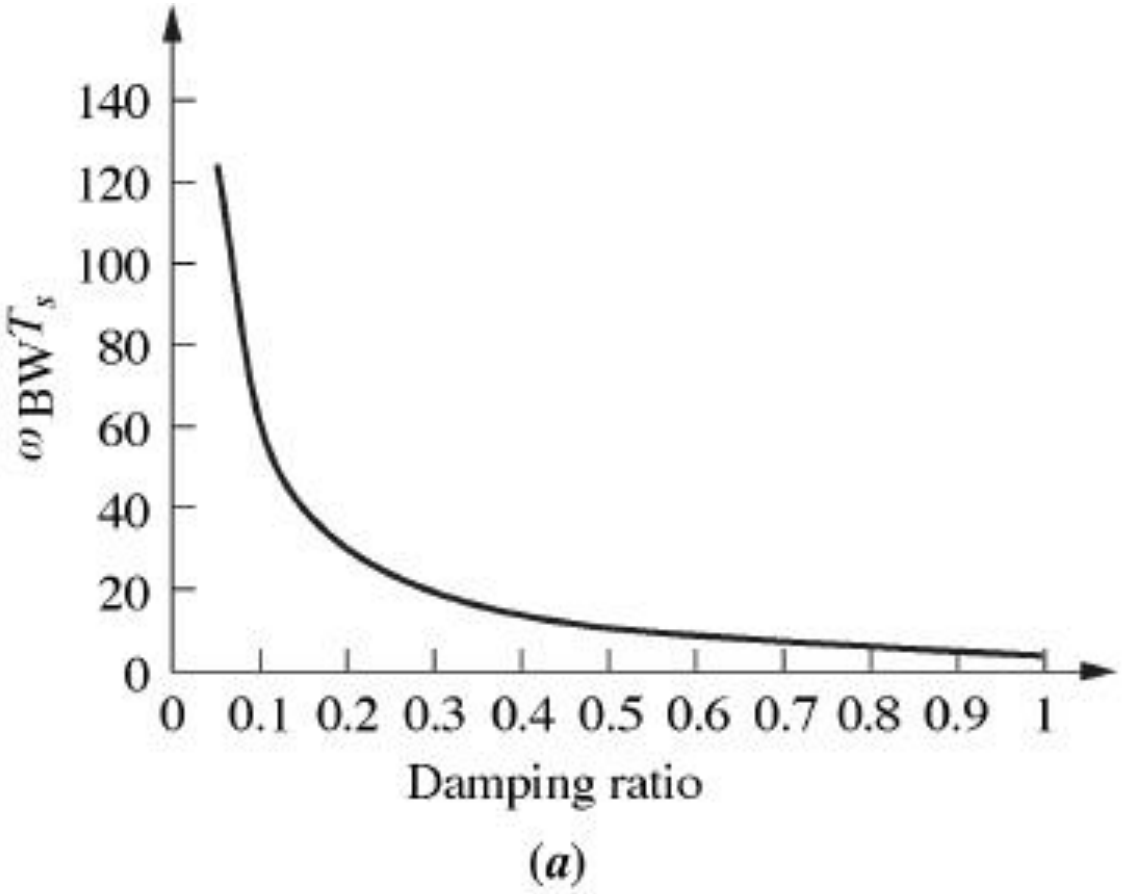
Response Speed and Closed – loop Frequency Responses

$$\omega_{BW} = \omega_n \sqrt{(1 - 2\zeta^2) + \sqrt{4\zeta^4 - 4\zeta^2 + 2}}$$

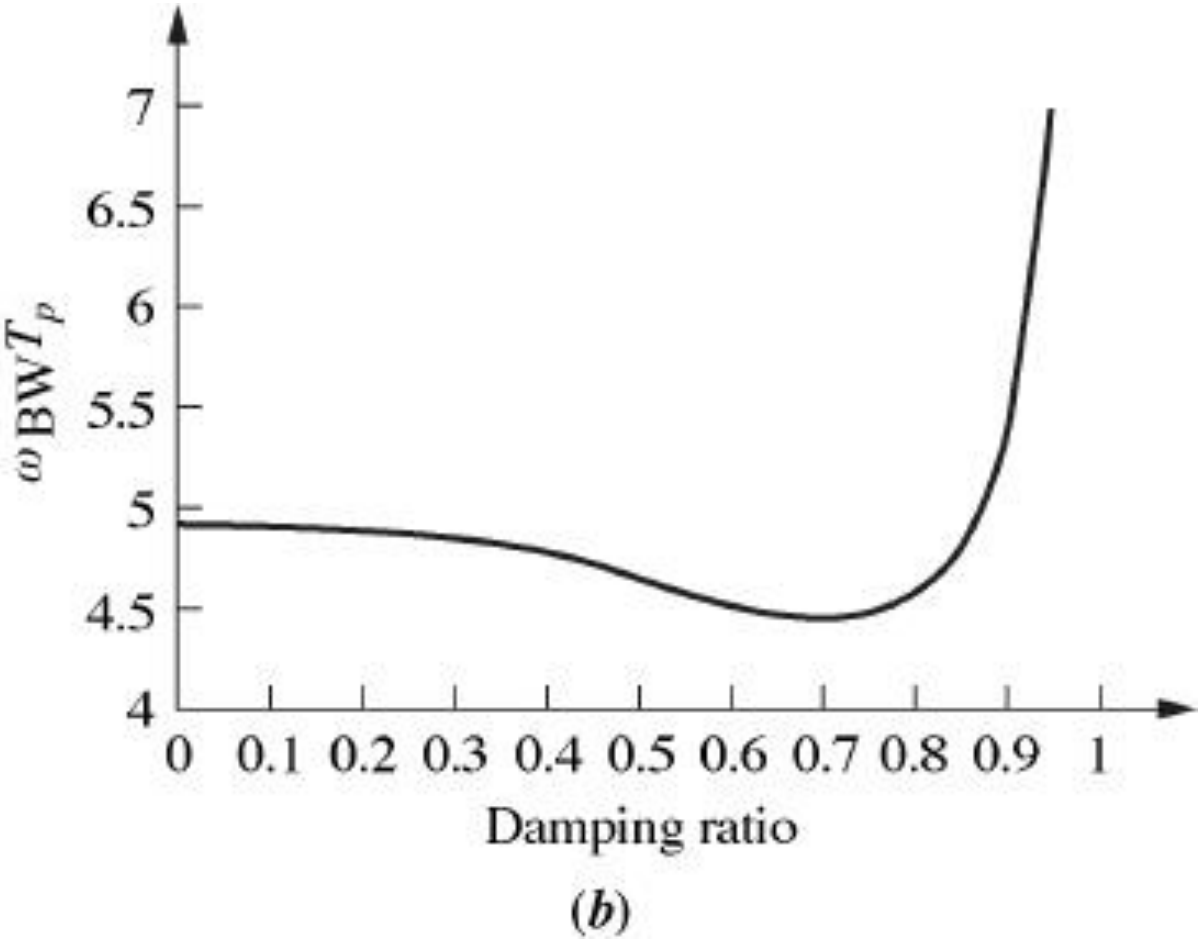
$$\omega_{BW} = \frac{4}{T_s \zeta} \sqrt{(1 - 2\zeta^2) + \sqrt{4\zeta^4 - 4\zeta^2 + 2}}$$

$$\omega_{BW} = \frac{\pi}{T_p \sqrt{1 - \zeta^2}} \sqrt{(1 - 2\zeta^2) + \sqrt{4\zeta^4 - 4\zeta^2 + 2}}$$

Response Speed and Closed – loop Frequency Responses

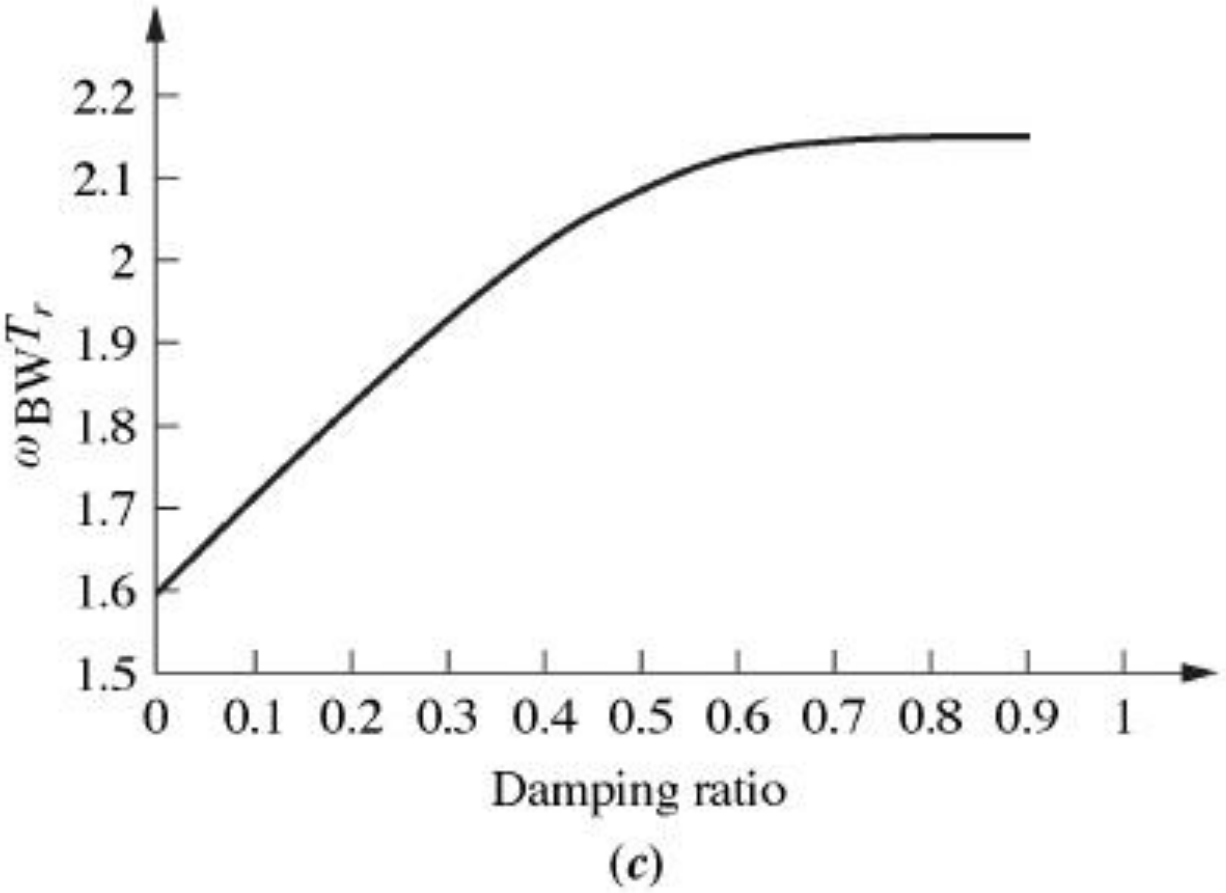


Response Speed and Closed – loop Frequency Responses



(*b*)

Response Speed and Closed – loop Frequency Responses



(*c*)