

Selected Answers from HW #7

8.20

a) $\zeta = \cos\left(\tan^{-1}\left(\frac{6}{2}\right)\right) = 0.316$

$$\tau = \frac{1}{2}$$

$$\omega_d = 6$$

$$\omega_n = \sqrt{40}$$

b) ζ, τ are undefined

$$\omega_d = 5$$

$$\omega_n = \sqrt{26}$$

c) $\zeta = 1$

$$\tau = \frac{1}{10}$$

$$\omega_n, \omega_d, \text{ are undefined}$$

d) $\zeta, \omega_d, \omega_n$ are undefined

$$\tau = \frac{1}{10}$$

8.23 Stable: $-2.5 < \mu < -2$

Neutral: $\mu = 2$

Unstable: $\mu > -2$ or $\mu < -2.5$

8.35 $m = 66.5 \text{ kg}; b = 558 \frac{Ns}{m}; k = 40,000 \frac{N}{m}$

8.36 $b = 5.34 \frac{Ns}{m}; K = 987 \frac{N}{m}$

1)
$$s_{1,2} = \frac{\left(-b \pm \sqrt{b^2 - 4(3kx_0^2)\left(\frac{J}{R^2} + m\right)}\right)}{2\left(\frac{J}{R^2} + m\right)}$$

2) $\ddot{x} + 0.6\dot{x} + ((0.3)^2 + (10\pi)^2)x = 0$

$$x_h(t) = A_1 e^{-0.3t} \cos(10\pi t + A_2)$$

3) $\ddot{x} + 0.3\dot{x} + 0.02x = 0$

$$x_h(t) = A_1 e^{-0.1t} + A_2 e^{-0.2t}$$

Supplemental Problems

4) Regular: $s_{1,2} = \pm j \sqrt{\frac{mgl}{J_{cg} + ml^2}}$

Inverted: $s_{1,2} = \pm \sqrt{\frac{mgl}{J_{cg} + ml^2}}$

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$$5) \quad ml^2\ddot{\theta} + bl^2 \cos^2(\theta) \dot{\theta} + kl^2 \sin(\theta) \cos(\theta) = mgl \cos(\theta)$$

$$\text{Linearized about } \theta = 0: \quad ml^2\ddot{\theta} + bl^2\dot{\theta} + kl^2\theta = mgl$$

$$6) \quad k \leq \frac{b^2}{4Jl^2}$$

$$7) \quad k = \left(\frac{1.8}{0.2}\right)^2 \left(\frac{J}{R^2} + m\right)$$

$$b = 9.2 \left(\frac{J}{R^2} + m\right)$$