RW 15.10

$$H(s) = \frac{40000}{s^2+20s+40000} \qquad H(s) = \frac{\Omega_r(s)}{\Omega(s)}$$

$$\Omega(t) = \Omega_0\left(1 + \frac{1}{4}\sin(2\Omega_0 t) + \frac{1}{8}\sin(4\Omega_0 t)\right)$$

a) if $\Omega_0 = 50$ rad/s find $\Omega_r(t)$

$$H(s)\Big|_{s\to jw} = \frac{40000}{(jw)^2 + 20jw + 40000}$$

$$H(jw) = \frac{40000}{-w^2+20jw+40000} \quad \frac{40000-w^2-20jw}{40000-w^2-20jw}$$

$$= \frac{1.6\times10^9 - 40000w^2 - 8\times10^5 jw}{(40000-w^2)^2 + 400w^2}$$

$$H(j50) = \frac{1.6\times10^9 - 1\times10^8 - 4\times10^7 j}{1.4\times10^9 + 2500}$$

$$= \frac{1.5\times10^9 - 4\times10^7 j}{1.4\times10^9}$$

$$= 1.07 - 0.0284j$$

$$|H(j50)| = \sqrt{1.07^2 + 0.0284^2}$$

$$= 1.07$$

$$\angle H(j50) = \text{atan}\left(\frac{0.0284}{1.07}\right) = 0.027$$

$$H(j100) = \frac{1.2\times10^9 - 8\times10^7 j}{9.04\times10^8} = 1.32 - 0.0885j$$

$$|H(j100)| = \sqrt{1.32^2 + 0.0885^2} = 1.33$$

$$\angle H(j100) = \text{atan}\left(\frac{0.0885}{1.32}\right) = 0.065$$

$$|H(j0)| = 40000 \qquad \angle H(j0) = \pi$$

$$\Omega_r(t) = \Omega_0\left(|H(j0)| + \frac{|H(j100)|}{4}\sin(100t + \angle H(j100)) + \frac{|H(j200)|}{8}\sin(200t + \angle H(j200))\right)$$

$$= 50\left(40000 + \frac{1.33}{4}\sin(100t + 0.065) + \frac{|H(j200)|}{8}\sin(200t + \angle H(j200))\right)$$

$40000 = 0$

no zeros

$s^2+20s+40000 = 0$

$$s = \frac{-20 \pm \sqrt{20^2 - 4(1\times10^5)}}{2}$$

$$= \frac{-20 \pm \sqrt{400 - 1.6\times10^6}}{2} = \frac{-20 \pm \sqrt{-1599600}}{2}$$

$$= \frac{-20 \pm 1265j}{2}$$

$$= -10 \pm 632j$$

$p = -10+632j, \; -10-632j$