9.3

a) $x_1(t) = x^2(t) = x(t) \cdot x(t)$

$\omega_m = \omega_{max} + \omega_{max} = 2\omega_{max}$

$\omega_s = 2\omega_m = 4\omega_{max}$

b) $x_2(t) = \frac{d}{dt}[x^2(t)]$

No effect of differentiation on Nquist rate

So, $\omega_s = 4\omega_{max}$ (same like 'a')

c) $x_2(t) = x_1(t) + \frac{d}{dt}x(t)$

$\omega_m = \max\left(x_1(t), \frac{d}{dt}x(t)\right)$

$\omega_m = \omega_{max}$

$\omega_s = 2\omega_{max}$

d) $x_4(t) = \int_{0}^{t} x(t)\,dt$

No effect of integrate

So, $\omega_s = 2\omega_{max}$

e) $x_5(t) = x(t) \cdot \cos \omega_0 t\, dt$

$\omega_m = \omega_{max} + \omega_0$

$\omega_s = 2(\omega_{max} + \omega_0)$

9.4)

a) $x_1(t) = x(t) + \cos \omega_0 t$

$\omega_m = \max\left(\frac{\omega_0}{2}, \frac{\omega_0}{2}\right)$

$\omega_s = 2 \times \frac{\omega_0}{2} = \omega_0$

b) $x_2(t) = x(t) \cdot \cos \omega_0 t$

$\omega_m = \frac{\omega_0}{2} + \omega_0 = \frac{3\omega_0}{2}$

$\omega_s = 3\omega_0$

c) $\omega_m = \frac{\omega_0}{2} + \omega_c$

$\omega_s = \omega_0 + 2\omega_c$

d) $x_4(t) = x^2(t) \cdot \sin \omega_c t$

$\omega_m = \left(\frac{\omega_0}{2} + \frac{\omega_0}{2}\right) + \omega_c$

$\omega_m = \omega_0 + \omega_c$

$\omega_s = 2(\omega_0 + \omega_c)$

Q.1) a) $x_1(t) = \cos 20\pi t + \sin 80\pi t$

$\omega_m = \max(20\pi, 80\pi)$

$\omega_m = 80\pi$

$\omega_s = 2 \times 80\pi = 160\pi$

b) $x_2(t) = \left(\frac{\sin 60\pi t}{\pi t}\right)^2 = 3600 \sin^2 c(60\pi t)$

using duality

$\sin^2\left(\frac{tc}{4}\right) = \frac{4\pi}{T} \Delta\left(\frac{w}{2c}\right)$

$\frac{t_c}{4} = 60 \Rightarrow t_c = 240\pi$