Vibrations & Waves Classwork 3 – (Solutions)

i) Pendulum

$$\omega_0 = \sqrt{\frac{g}{L}} \Rightarrow L = \frac{g}{\omega_0^2} = \frac{g}{(2\pi f)^2} = 0.253m$$

Woofer

$$\omega_0 = \sqrt{\frac{s}{m}} \Rightarrow s = \frac{\omega_0^2}{m} = \frac{(2\pi f)^2}{m} = 39.48N/m$$

ii) $\omega_1 = \omega_0(pendulum) = \omega_0(woofer) = 6.283rad/s$

iii)

$$\omega_2 = \sqrt{\left(\omega_0^2 + \frac{2S_c}{m}\right)}$$

$$\Rightarrow \omega_2^2 - \omega_0^2 = \frac{2S_c}{m}$$

$$\Rightarrow \frac{m}{2}\left(\omega_2^2 - \omega_0^2\right) = S_c = 4.76N/m$$

iv)

$$s = \frac{\omega_0^2}{m} = \frac{(2\pi f)^2}{m} = 3{,}948N/m$$

v)

$$Q = \frac{m\omega_0}{r} = \frac{\omega_0}{\omega_2 - \omega_1}$$

Bandwidth of oscillating system:

=> $\omega_2 - \omega_1 = r/m$

f_2 = 20 Hz => ω_2 = 125.66 rad/s

f_1 =1 Hz => ω_1 = 6.28 rad/s

=> $r = m(\omega_2 - \omega_1) = 1(125.66 - 6.28) = 119.4 Ns/m$

vi) Longitudinal

$\lambda = v/f = 344/10 = 34.4m$

$k = 2\pi/\lambda = 0.183 rad/m$

vii) $\psi(x,t) = 0.05\cos(62.8t - 0.183x)$

viii) Difference in T:

$$\frac{v(10^oC)}{v(30^oC)} = \sqrt{\frac{283K}{303K}} = 0.9664$$

$\lambda(10^oC) = 33.2m$

ix) $t = d/v = 1000/(0.9664 \times 344) = 3s$