First Name: ____________________

Last Name: ____________________

Student Number: ____________________

MIE 200F – Test No. 9 – November 30, 1998
Test Duration – 20 minutes

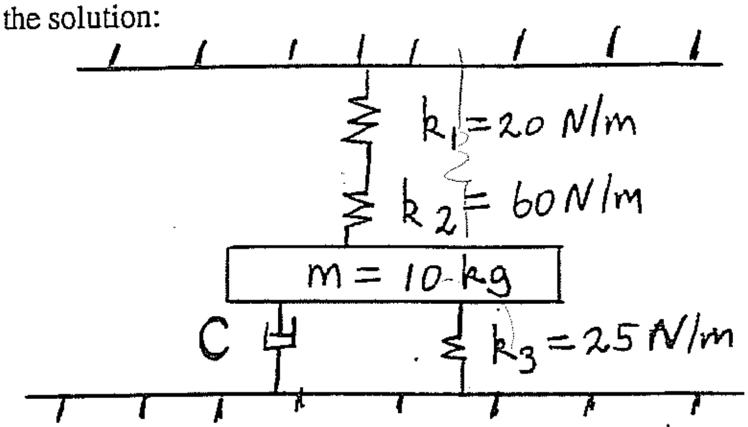
(a) What is the natural frequency ω_n of the system if the damper C = 0?

(b) What damper value C is required to reduce the vibration frequency by about 2%?

The equation: $\ddot{x} + 2\zeta\omega_n\dot{x} + \omega_n^2 x = 0$ has the solution:

$x(t) = C_1 \sin(\omega_d t + \phi)\exp(-\zeta\omega_n t)$,
where C_1 and ϕ are unknown constants,

and the damped frequency $\omega_d = \omega_n\sqrt{1-\zeta^2}$



$$K_{total} = k_3 + \frac{k_1 k_2}{k_1 + k_2}$$

$$= 25 + \frac{(20)(60)}{20+60}$$

$$= 25 + 15$$

$$= 40 \text{ N/m}$$

(a) $F = -40x = m\ddot{x}$

$$10\ddot{x} + 40x = 0$$

$$\ddot{x} + 4x = 0$$

$$\omega_n^2 = 4 \Rightarrow \boxed{\omega_n = 2 \ s^{-1}}$$

(b) $\frac{\omega_d}{\omega_n} = \sqrt{1-\zeta^2} = 0.98 \Rightarrow \zeta = 0.199$

$$\ddot{x} + 2\zeta\omega_n\dot{x} + \omega_n^2 x = 0 \Leftrightarrow \ddot{x} + \frac{c}{m}\dot{x} + 4x = 0$$

$$\Rightarrow 2\zeta\omega_n = c/m$$

$$(2)(0.199)(2) = c/10$$

$$\boxed{c = 7.96 \ \frac{N}{m/s}}$$

18