PHYSICS EXAMINATION PROBLEMS
SOLUTIONS AND HINTS FOR STUDENT SELF-STUDY

Module Code and Lecturer	PHY1106: AU and PV
Name of module	Oscillations section (PV)
Date of examination	June 2003

1. Notework / lectures: Look at expression for impedance of capacitor.
Freq. in denominator implies impedance is inversely proportional to freq. so as freq. increases, the impedance decreases.

Notework / lecture derivation of LCR complex impedance.

Notework / lecture details about the phases etc.

Use standard equation for phase difference ϕ: i.e. $\tan\phi = \dfrac{\omega L - 1/\omega C}{R}$
(n.b. convert *f* to ω)

Answer: $\phi = 37° = 0.65$ rads.

At resonance, $\omega_0 = 1/\sqrt{LC}$ = 63 rads /s therefore $f_0 = 10.1$ Hz

Expression for average power: $P_{Av} = \dfrac{V_0^2}{2Z}\cos\phi$

which at resonance reduces to $P_{Av} = \dfrac{V_0^2}{2R}$ and gives $P_{Av} = 289$ W

Use $Q = \dfrac{\omega_0 L}{R}$ which gives Q = 0.16.

2. Notework / lectures about balancing forces and the sum of individual forces etc. to give the forced damped harmonic oscillator equation.

For the picture; describe the: driving force; damping force, restoring force etc.

Notework / lectures derivation and proof as required for the complex value of *A*.

The phase term ϕ will be zero under conditions of resonance. This occurs when: $\omega_0 = \sqrt{\frac{k}{m}}$ i.e. when $\omega_0 = 5$ rads/s or when $f_0 = 0.8$ Hz.

Max. displ. (at resonance) = $\frac{F_0}{\omega b}$ (from given equation) = 0.25 m.

3. Clearly, amplitude remains unchanged, but a second block added:

so resonant frequency $\omega_0 = \sqrt{\frac{k}{m}}$ and therefore ω_0 decreases by $\sqrt{2}$.

Max KE and PE stay unchanged (since $E_{total} = \frac{1}{2} k A^2$).

Notework / lectures for this proof re. equation of motion solution.

First calculate the value of the spring constant *k*, using $F = kx$ (= 50N/m).

Then use standard equation $\omega_0 = \sqrt{\frac{k}{m}}$ to give $\omega_0 = 7.1$ rads /s or $f = 1.13$ Hz.