EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 1996/97

EXTERNAL DEGREE

(June-August 2004)

PHYSICAL OPTICS & WAVES AND VIBRATIONS

EXPH 204 & 205

Time: 02 hour.

Answer Four questions only selecting Two from each section.

SECTION A

1. (a) When two monochromatic and coherent light beams having intensities I_1 and I_2 are superimposed and the intensity variations across the observed fringe pattern is given by

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}cos\delta$$

where δ is the phase difference between the two beams at the observation place. Give a quantitative plot for the variation of intensity against δ.
Show that in a Young's double slit experiment (assume that the two slits are identical)

$$I = 4I_0 cos^2\left(\frac{\pi x d}{\lambda D}\right)$$

where the symbols have their usual meanings.

(b) In a double slit experiment, $d = 5.0mm$ and $D = 1.0m$. Two interference patterns can be seen on the screen. One due to light of wavelength $4800A^0$ and other due to light of wavelength $6000A^0$. What is the separation on the screen between the 3^{rd} order bright fringes of the two patterns?

2. (i) Define *monochromatic waves* and *coherent sources* of light. Describe the conditions necessary for producing interference of light.

(ii) Explain how did Fresnel obtain those conditions in his bi-prism experiment by drawing suitable diagrams.

(iii) In an experiment with Fresnel bi-prism, fringes for light of wavelength $5 \times 10^{-5}cm$ are observed with fringe width $0.2mm$ at a distance $175cm$ from the prism. The prism is made of glass of refractive index 1.5 and is $25cm$ from the illuminated slit. Calculate the prism angle of one of the prisms in the bi-prism.

3. (i) Explain the formation of Newton's rings and give a clear labeled diagram of an experiment that may be used for observing the fringes. Find the phase difference and obtain the conditions for the formation of dark rings.

(ii) A film of oil of refractive index 1.7 is placed between an equi-convex lens and a flat plate in a Newton's rings arrangement. The refractive index of the glass is 1.5 and the focal length of the lens is $100cm$. Find radius of the 10^{th} dark ring when the light of wavelength $6000A^0$ is used.

SECTION B

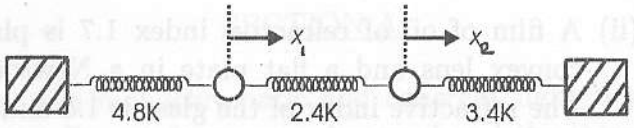
4. (i) One end of a massless spring is connected to a fixed wall and other is connected to a mass m. The mass oscillates on frictionless floor. Show that the motion of the mass is simple harmonic motion. Show that the displacement of the mass is in sinusoidal form and the total energy of the system is constant.

(ii) A mass on the end of a spring oscillates with an amplitude of $5cm$ at a frequency of $1Hz$. At $t = 0$ the mass is in the equilibrium position. Find the displacement, velocity and acceleration at $t = 8/3$ *sec*.

5. An object of mass $0.2kg$ is hung from a spring whose spring constant is $80Nm^{-1}$. The body is subjected to a resistive force given by $-bV$, where V is its velocity in ms^{-1} and $b = 4Nm^{-1}$. The object is subjected to a sinusoidal driving force given by $F(t) = F_0 sin\omega t$, where $F_0 = 2N$ and $\omega = 30rad\ sec^{-1}$. Find

(i) Amplitude of the forced oscillation

(ii) Acceleration of the mass.



6. Two particles each of mass m are connected by three elastic strings of spring constants $4.8K, 2.4K$ and $3.4K$ respectively as shown in the diagram. The ends of the outer strings are held fixed with the whole system under tension. Show that the equations of longitudinal motion of the system are,

$$m\ddot{x}_1 = -7.2kx_1 + 2.4kx_2$$

$$m\ddot{x}_2 = 2.4kx_1 - 5.8kx_2$$

where x_1 and x_2 are the displacements of the particles from there equilibrium positions. Given that,

$$\frac{1}{2\pi}\sqrt{\frac{k}{m}} = 1Hz$$

Find the frequency and relative amplitudes of the masses for each normal mode.