UNIVERSITY OF FORT HARE

SUPPLEMENTARY EXAMINATIONS

JAN/FEB 2019

University of Fort Hare
Together in Excellence

WAVE & OPTICS

(PHY 221)

DURATION: 3Hours

MARKS: 100

INTERNAL EXAMINER

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MODERATOR

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INSTRUCTIONS

Answer any five(5) questions

Question 1

(a) Derive the wave equation. [4]

(b) Show that $y = f(ct + x)$ satisfies the wave equation. [2]

(c) Show that the wave profile $y = f(ct - x)$ remains unchanged with time. [2]

(d) Show that for a left – going wave, $\frac{\partial y}{\partial t} = c\frac{\partial y}{\partial x}$. [2]

(e) Derive an expression for the total energy In a wave. [5]

(f) A wave of amplitude 0.1 m propagates along a string of linear mass density 0.01 kg/m, at a frequency of 5 Hz and speed of 9.55 m/s. Determine the rate at which energy is dissipated per cycle. [5]

Question 2

(a) Consider two long strings of different densities, joined together a $x = 0$, and subject t the same tension T. Assume the wave is incident from the negative x – direction. At the junction the wave suffers partial reflection and partial transmission.

(i) State the boundary conditions . 2 x [3]

(ii) Determine the coefficients of reflection and transmission. [10]

(b) Show that $v_g = v - \lambda \frac{\partial v}{\partial \lambda}$ [4]

Question 3

(a) For standing waves on strings of finite length, show that the displacement of the nth harmonic is given by $y_n = (A_n cos\omega_n t + B_n sin\omega_n t) sin\frac{n\pi}{l}x$. [6]

(b) Show that this displacement satisfies the the time independent form of the wave equation:

$$\frac{\partial^2 y}{\partial x^2} + k^2 y = 0$$

[4]

(c) A string of length l, mass per unit length σ, and tension T is initially displaced a distance b ($b \ll l$) at the midpoint and is then released. Determine the Fourier coefficients for the subsequent motion. [6]

(d) Write the first four terms of the series. [4]

Question 4

(a) In Young's double slit experiment, determine the positions from the central bright fringe, of the bright and the dark spots. [8]

(b) A viewing screen is separated from a double-slit source by 1.2 m. The distance between the two slits is 0.03 mm. The second – order bright fringe is 4.5 cm from the centre line.

- (i) Determine the wavelength of the light. [2]
- (ii) Calculate the distance between adjacent bright fringes. [4]
- (iii) A light source emits visible light of two wavelengths: $\lambda = 430\ nm$ and $\lambda' = 510\ nm$. The source is used in a double-slit interference experiment in which $L = 1.50\ m$ and $d = 0.0250\ mm$. Find the separation distance between the third – order bright fringes. [6]

Question 5

(a) Calculate the minimum thickness of a soap-bubble film that results in constructive interference in the reflected light if the film is illuminated with light whose wavelength in free space is $\lambda = 600\ nm$. [4]

(b) What if the film is twice as thick? Does this situation produce constructive interference? [2]

(c) Derive an expression between object and image distances for a spherical refracting surface. [8]

(d) A spherical convex mirror has a radius of curvature with a magnitude of 40.0 cm. Determine the position of the virtual image formed and magnification for object distances of 30.0 cm and 60.0 cm. [6]

(e) Calculate the minimum thickness of a soap-bubble film that results in constructive interference in the reflected light if the film is illuminated with light whose wavelength in free space is $\lambda = 600\ nm$. [4]

(f) What if the film is twice as thick? Does this situation produce constructive interference? [2]

(g) Derive an expression between object and image distances for a spherical refracting surface. [8]

(h) A spherical convex mirror has a radius of curvature with a magnitude of 40.0 cm. Determine the position of the virtual image formed and magnification for object distances of 30.0 cm and 60.0 cm. [6]

END