

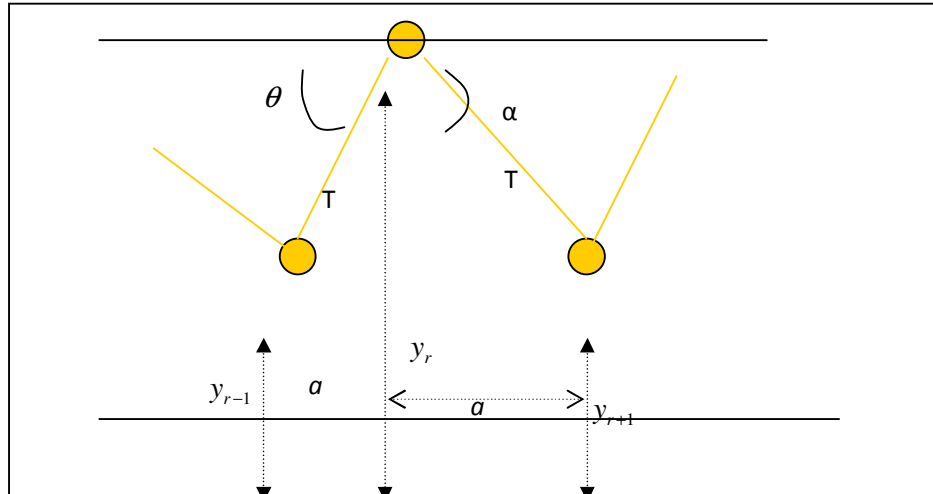
# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

## Bed Physics

**Test 1:** SPH1201 WAVES AND VIBRATIONS: **Duration:** 2hr 30min

**Date:** 24 September 2010

1. (a) The figure below illustrates coupled oscillations of a loaded string.



$n$  equal masses ( $m$ ) are spaced at equal distances ( $a$ ),

- (i) Show that the equation of motion for the  $r^{\text{th}}$  mass is given by:-

$$\left( \frac{d^2 y_r}{dt^2} \right) = \frac{T}{m_a} (y_{r-1} + y_{r+1} - 2y_r) \quad [5]$$

- (ii) By considering  $y_r = A r e^{i\omega t}$ , show that this equation can be reduced to:

$$-Ar - 1 + \left( 2 - \frac{ma\omega^2}{T} \right) Ar - Ar + 1 = 0 \quad [5]$$

- (iii) Show how equation (i) by considering appropriate limits can be used to derive the *Wave Equation*. [7]

- (v) Show that the dimensions of  $\rho/T$  are similar to those of  $\frac{1}{v^2}$ . [3]

2. Show that the Kinetic energy for one wavelength for a mechanical progressive wave is given by:  $KE = \frac{1}{4} \lambda \mu U_0^2$ , where  $\mu$  mass per unit length and  $U_0 = 2\pi fA$ , and A is the Amplitude.

[10]

3. (a) Red light of wavelength 633nm from a helium-neon laser passes through a slit 0.350mm wide. The diffraction pattern is observed on a screen 3.00m away. Define the width of bright fringe as the distance between the minima on either side.

(i) What is the width of the central bright fringe? [6]

(ii) What is the width of the first bright fringe on either side of the central one? [5]

(b) Deduce an expression for the Brewster angle and Calculate the Brewster angle for a material having a refractive index of 3.5. [8]

(c) Unpolarized light with intensity  $I_0$  passes through a linear polarizer. It then passes through a second polarizer (the second polarizer is usually called the analyzer) whose transmission axis makes an angle of  $30^\circ$  with the transmission axis of the first polarizer. What is the intensity of the light after the second polarizer, in terms of the intensity of the initial light? [4]

4. The equation of a certain transverse wave is:

$$y(x,t) = (4.00\text{cm}) \sin 2\pi \left| \frac{t}{0.0300\text{s}} - \frac{x}{50.0\text{cm}} \right|$$

Determine the waves:-

(i) Amplitude [5]

(ii) Wavelength [5]

(iii) Frequency [5]

(iv) Speed of propagation. [5]

(v) In which direction is the wave propagating. [5]

5. The following two waves in a medium are superposed:

$$Y_1 = A \sin(5x - 10t) \text{ and } Y_2 = A \sin(4x - 9t)$$

Where x is in metres and t in sec:-

(i) Write an equation of combined disturbance [5]

(ii) What is its group velocity? [5]

(iii) What is the disturbance between points amplitude in the combined disturbance? [5]

6. A person on a railroad car blows a trumpet sounding at 440 Hz. The car is moving toward a wall at  $20 \text{ ms}^{-1}$ . Taking the speed of sound to be  $343 \text{ ms}^{-1}$ :- Calculate:-

(i) The frequency of the sound as received at the wall [6]

(ii) The frequency of the reflected sound arriving back at the source. [6]

**THE END**