KABARAK UNIVERSITY

UNIVERSITY EXAMINATIONS

2008/2009 ACADEMIC YEAR

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHYS 210

COURSE TITLE: OSCILLATIONS AND WAVES

STREAM: Y 2 S1

DAY: TUESDAY

TIME: 2.00 – 4.00 P.M

DATE: 30/11/2010

INSTRUCTIONS:

- Answer Question **ONE** and any other **TWO** Questions. Question **ONE** carries **30marks** while each of the other Two Questions carry 2**0marks**.

PLEASE TURN OVER

QUESTION 1 (30 marks)

(a) Define the following terms **(2marks)**

i). Periodic motions

ii). Sinusoidal vibrations

(b) Consider the general equation of a simple harmonic motion defined by

$$X = ASin(\varpi t + \Psi)$$

i). Sketch a graph representing this motion **(2marks)**

ii). Find the displacement (X_0) and velocity (V_0) expressions of this motion at $t = 0$ **(4marks)**

iii). Hence show that

$$A = \left[X_0^{\,2} + \left(\frac{V_0}{\varpi} \right)^2 \right]^{\frac{1}{2}}$$ **(4marks)**

(c) Consider the vector Z defined by the equation $Z = Z_1 Z_2$ where $Z_1 = a + jb$ and $Z_2 = c + jd$. Show that the length Z is the product of the length of Z_1 and **(3marks)**

(d) State two quantities of a simple harmonic oscillator **(2marks)**

(e) Define the following terms **(2marks)**

i). Stress

ii). Strain

(f) A mass of 0.5Kg is suspended on a steel wire of length 50cm and diameter 1mm. Given that for steel Young modulus $Y = 2.0 \times 10^{11} N/m^2$, determine

i). The extension produced on the wire **(3marks)**

ii). The period of oscillation of the system **(3marks)**

(g) Differentiate between the following and state two examples of each **(4marks)**

i). Transverse waves

ii). Longitudinal waves

(h) State one difference between standing waves and progressive waves **(1mark)**

QUESTION 2 (20 marks)

a) Consider the given wave equation

$$y = 4Sin200\pi\left(t - \frac{x}{3000}\right)$$

Determine for the wave

i). The direction **(1mark)**

ii). The amplitude **(1mark)**

iii). The period **(2marks)**

iv). The wavelength **(2marks)**

v). The speed **(2marks)**

b) Given the standing wave equation

$$y = 4Cos\frac{\pi}{15}xSin\frac{2\pi}{0.01}t$$

Determine

i). The amplitude of the progressive wave generating the standing wave **(2marks)**

ii). The wavelength of the progressive wave **(2marks)**

iii). The angular speed of the progressive wave **(2marks)**

iv). The distance x for the first antinode **(2marks)**

v). The period of the progressive wave **(2marks)**

c) State two difference between standing waves and progressive waves **(2marks)**

QUESTION 3 (20 marks)

a) Define the following terms **(3marks)**

i). Particle velocity

ii). Phase velocity

iii). Group velocity

b) Show that group velocity v_g is given by

$$v_g = v - \lambda\frac{dv}{d\lambda}$$; Where v is the phase velocity **(5marks)**

c) Obtain the Fourier series of the given function **(2marks)**

$$x(t) = e^{j200t}$$

d) State two conditions for two source interference **(2marks)**

e) Light of wavelength 500nm is incident on two small parallel slits separated by 1.0mm. After passing through the slits, the light is focused onto a screen 1.5m away from the slits, calculate;

i). The angle for the first fringe formation **(3marks)**
ii). The observed fringe spacing on the screen **(3marks)**

f) Find the beat period of beats produced when sound notes of frequencies 438Hz and 443Hz are sounded together. **(2marks)**

QUESTION 4 (20 marks)

a) Define the following terms **(3marks)**
i). Normal mode of vibration
ii). Degree of freedom
iii). Doppler effect

b) The frequency of a car horn is measured by a stationary observer as 200Hz, when the car is at rest. Determine the frequency that will be heard if the car is approaching the observer at a speed of $30 m/s$. Take speed of sound in air to be $330 m/s$ **(3marks)**

c) Consider an LC with current (i) flowing in it. Show that at any time (t), the charge (q) on any plate of the capacitor can be expressed in Fourier series defined by

$$q = q_0 Sin\left(\frac{t}{\tau} + \alpha\right)$$

Where $\tau = \sqrt{LC}$, $q = q_0$ at $t = \tau$ and $\alpha =$ phase constant **(10marks)**

d) A string of length 1m, mass 25g and fixed at both ends is stretched by tension of 10N. If the string is made to vibrate with fundamental frequency of 100Hz, calculate;
i). The wavelength of the second harmonic **(2marks)**
ii). The speed of the wave on the string **(2marks)**

QUESTION 5 (20 marks)

a) i) Differentiate between open and closed pipe **(2marks)**

ii) An organ pipe open at one end is 1.5m long. Given that the speed of sound is $300 m/s$ calculate the second harmonic

I) The frequency **(3marks)**

II) The wavelength **(2marks)**

c) i) Define resonance as used with simple harmonic oscillators **(1mark)**

ii) Consider an undamped harmonic oscillator of mass (m), spring constant (k) with harmonic forcing. Show that for this system, the amplitude is extremely large at resonance **(6marks)**

d) i) Differentiate between odd and even functions **(2marks)**

ii) The motion of the spot on a cathode ray oscilloscope screen when alternating voltages are applied simultaneously on the X and Y plates can be described by

$$X = a\sin\omega t$$
$$Y = b\sin(\omega t + \alpha)$$

Show that the motion of the spot degenerates into a line when the voltages are in phase with each other **(4marks)**