# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2021/2022 ACADEMIC YEAR

### SECOND YEAR FIRST SEMESTER
### SUPLEMETARY EXAMINATIONS

**FOR THE DEGREE OF BED (SCIENCE)**

**COURSE CODE:** SPH 211

**COURSE TITLE:** WAVES AND OSCILLATIONS

**DATE:** 15/72022 **TIME:** 2:00PM-4:00AM

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**INSTRUCTIONS TO CANDIDATES**

TIME: 2 Hours

**Answer question ONE and any TWO of the remaining**

## QUESTION ONE (30 marks) compulsory

(a) State any three properties of longitudinal progressive waves. (3mks)

(b) If the frequency of the tuning fork is 400Hz and the velocity of sound in air is 320m/s, find how far sound travels while the fork completes 30 vibrations. (3mks)

(c) Define the following terms:

i) Vibration (1mk)

ii) Phase (1mk)

(d) Consider a circuit of inductance, L, resistance, R and Capacitance, C through which current, I, passes. Show that:

$$L\ddot{q} + R\dot{q} + \frac{q}{C} = 0 \quad \text{(5mks)}$$

(e) A condenser of capacity 1 $\mu F$, an inductor of 0.2 henry and a resistor of 800 $\Omega$ are joined in series. Show that the circuit is oscillatory. (4mks)

(f) Given the equation of the damped simple harmonic motion oscillator $m\ddot{x} + r\dot{x} + kx = 0$ Obtain the solution for the equation in terms of resistance term and stiffness term

(10mks)

(g) Suppose in Doppler effect, a source, $S'$ and an observer, $O'$ move in the same direction with velocity u and v respectively. Bring the observer to rest by superimposing a velocity –v on the system to show that $O'$ now registers a frequency:

$$v''' = \frac{v(c-v)}{c-u} \quad \text{(3mks)}$$

## QUESTION TWO (20 marks)

(a) Describe the effect of the transient term in the motion of the mechanical forced oscillator (7mks)

(b) Consider two identical pendulums, each a light rigid rod of length, l supporting a mass, m and coupled by a weightless spring of stiffness k and a natural length equal to the separation of the masses at zero displacement, show that their motion is completely described by:

$$\ddot{Y} + (\omega_0^2 + \frac{2k}{m})Y = 0 \text{ where } Y = x - y \text{ and } \omega_0^2 = \frac{g}{l} \quad \text{(13mks}$$

## QUESTION THREE (20 marks)

(a) Suppose that a particle moves under the simultaneous influence of two simple harmonic oscillations of equal frequency, one along the x-axis, the other along the perpendicular y-axis. Describe the subsequent motion due to superposition of the two influences. (11mks)

(b) Distinguish between logarithmic decrement and relaxation time (2mks)

(c) State the properties of longitudinal progressive waves (4mks)

(d) Define the following terms as used in wave motion:

i) Rarefaction (1mk)
ii) Amplitude (1mk)
iii) Particle velocity (1mk)

## QUESTION FOUR (20 marks)

(a) State the characteristics of wave motion (4mks)

(b) A simple harmonic motion is represented by the equation:

$y = 10\sin(10t - \frac{\pi}{6})$ where y is measured in metres, t in seconds and phase angle in radians. Calculate:

i) The frequency (3mks)
ii) The time period (3mks)
iii) The maximum velocity (4mks)
iv) The maximum acceleration (3mks)

(c) Outline the pieces of information from steady state behavior of a wave (3mks)

## QUESTION FIVE (20 marks)

(a) Consider a mechanical oscillator of mass, m, stiffness, k and resistance, r being driven by an alternating force, $F_0 \cos \omega t$, show that the displacement, x, of the oscillator is given by:

$x = \frac{-iF_0 e^{i(\omega t - \phi)}}{\omega Z_m}$ hence discuss its solution (16mks)

(b) State any three information from the steady state behavior of displacement x of a forced oscillator. (3mks)

(c) State the voltage equation in the electrical case of forced oscillatory motion (1mk)