KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BSC (PHYSICS) AND B.ED (SCIENCE)

COURSE CODE: SPH 211

COURSE TITLE: WAVES AND VIBRATIONS

DURATION: 2 HOURS

DATE: 17TH JANUARY 2018 TIME: 9 – 11AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **3** printed pages. Please Turn Over

You may use

- $g = 9.8m/s^2$

Question one (30 marks)

a) Write down three examples of motions having one degree of freedom. (3marks)
b) Discuss the importance of studying simple harmonic motion. (2marks)
c) Discuss the basic properties of a system that makes it to oscillate. (4marks)
d) Show that for an LC circuit the restoring force due to repulsion between electrons constitutes Simple Harmonic Motion. (6marks)
e) Show that the relaxation time for amplitude of a wave is given by $\frac{2m}{r}$ where the symbols have their usual meaning. (3marks)
f) By considering the variation of kinetic and potential energy of a simple harmonic oscillator derive the equation of simple harmonic oscillator (4marks)
g) Discuss the velocities associated with wave motion. (6marks)
h) A simple pendulum clock 2.5m ticks each time the pendulum bob reaches its maximum displacement in either direction. What is the time interval between the ticks? (2marks)

Question two (20 marks)

a) Write down the differential equation for motion representing forced vibrations (2marks)
b) The displacement of an oscillator is given by $y = a\sin(\omega t - \alpha)$ .Show that if an external force $F_0 \sin \omega t$ is applied to this motion then the phase α will be given by $\tan^{-1}\left(\frac{r}{\left(\frac{s}{\omega} - m\omega\right)}\right)$. (8marks)
c) Obtain the expression for the value of the spring constant when two masses m_1 and m_2 are coupled by a spring of stiffness S with natural length l are given an extension x units. (10marks)

Question three (20 marks)

a) What is meant by simple harmonic motion? (1mark)
b) Discuss the characteristics of simple harmonic motion. (3marks)
c) Show that the total energy of a system executing simple harmonic motion varies as the square of the amplitude. (4marks)
d) Show that for two simple harmonic motions given as
$x_1 = a_1 \cos(\omega t + \alpha_1)$ and $x_2 = a_2 \cos(\omega t + \alpha_2)$ the resultant amplitude is given by
$R = \sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos(\alpha_1 - \alpha_2)}$ (12marks)

Question four (20 marks)

a) A sodium chloride molecule has a natural vibration frequency of 1.14×10^{13}Hz and its effective mass equals to its reduced mass. Calculate the value of the interaction force constant given that the masses of sodium chloride atoms are 3.84×10^{-26}kg and 5.85×10^{-26}kg respectively. (10marks)

b) A wave has a displacement $x = Ae^{-pt}\sin(qt + \emptyset)$. Show that its logarithmic decrement after one oscillation is given by $p\tau = \delta$ where $\tau = 1$ period. (10marks)

Question five (20 marks)

a) A ballistic galvanometer at zero displacement $t = 0$ experiences a sudden impulse and receives a quantity of electric charge which gives it a slight spot an initial velocity v over a linear scale. Show that at maximum displacement $t = \frac{1}{p}$ the displacement at that instant is given by $x = 0.368\left(\frac{2mv}{r}\right)$. (10marks)

b) What is meant by logarithmic decrement? (1mark)

c) A wave has a displacement$\boldsymbol{x = Ae^{-pt}\sin\left(qt + \frac{\pi}{2}\right)}$. Show that its logarithmic decrement after one oscillation is given by $p\tau = \delta$ where $\tau = 1$ period. (9marks)