(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
SUPPLEMENTARY/SPECIAL EXAMINATIONS

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

COURSE CODE: SPH 211

COURSE TITLE: WAVES AND VIBRATIONS.

EXAM DURATION: 2 HOURS

DATE: 02/10/2018 TIME: 11:30-1:30PM

INSTRUCTIONS TO CANDIDATES

- Answer question one and any other two questions two (2) questions. Question one is compulsory and carries 30 marks, the other questions carry 20 marks each.

You may use

- $g = 9.8m/s^2$

Question one

a) Briefly discuss two categories of motion of physical systems giving examples in each case. (2marks)
b) Discuss the basic properties of a system that makes it to oscillate. (4marks)
c) Show that for an LC circuit the restoring force due to repulsion between electrons constitutes Simple Harmonic Motion. (6marks)
d) Show that the relaxation time for amplitude of a wave is given by $\frac{2m}{r}$ where the symbols have their usual meaning. (3marks)
e) Derive the wave equation by a considering a vertical displacement of very short section of a uniform string as a simple oscillator. (7marks)
f) Discuss the velocities associated with wave motion. (6marks)
g) 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

a) Show that the periodic time of the oscillators in an LC circuit is given by $T = 2\pi\sqrt{LC}$ where the symbols have their usual meaning. (10marks)
b) Derive the expression for the angular frequency ω of a torsional oscillator. (5marks)
c) The balance wheel in a watch has rotational inertia of $1.24 \times 10^{-7}\text{kgm}^2$.What should be the torsional constant of the hairspring if the period of the wheel's torsional oscillations is to be 1.00s? (5marks)

Question Three

a) Show that for two SHM motions given as $x_1 = a_1 \sin(\omega t + \emptyset_1)$ and $x_2 = a_2 \sin(\omega t + \emptyset_2)$ the resultant displacement is $x = R \sin(\omega t + \emptyset)$ (10marks)
b) Two perpendicular waves having the same frequency are given as $x = a_1 \sin(\omega t + \emptyset_1)$ and $y = a_2 \sin(\omega t + \emptyset_2)$.Show that when $a_1 = a_2$ and $\emptyset_2 - \emptyset_1 = n\pi$ where $n = 0,1,2 \ldots$ then the waves are plane polarized. (10marks)

Question four

a) Two perpendicular waves having the same frequency are given as $x = a_1 \sin(\omega t + \emptyset_1)$ and $y = a_2 \sin(\omega t + \emptyset_2)$.Show that when $a_1 = a_2$ and $\emptyset_2 - \emptyset_1 = \left(n + \frac{1}{2}\right)\pi$ then the waves are circularly polarized. (10marks)
b) An object is rotating in a circular path. Show that at the extreme end of its motion its acceleration is not zero even though the velocity is zero. (6marks)
c) An astronaut in an orbiting spacecraft is weighed by being strapped to a spring of constant $k = 400\text{Nm}^{-1}$ and set into simple harmonic motion. If the oscillation period is 2.5s, what is the astronaut's mass? (4marks)

Question Five

a) Given that $x = asin2\omega t$ and $y = bsin\omega t$,show that the superposition of the two vibrations result into Lisajous figures. (8marks)

b) Sketch and describe the Lisajous figures formed. (2marks)

c) A wave has amplitude of 5cm and a period of 2s, calculate the velocity of the particle at a position where acceleration is $\frac{1}{2}$ its maximum value. (10marks)