EMBU UNIVERSITY COLLEGE

(A Constituent College of the University of Nairobi)

2015/2016 ACADEMIC YEAR

FIRST SEMESTER EXAMINATION

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SPH 201: MECHANICS II

DATE: DECEMBER 7, 2015 **TIME: 14:00-16:00**

INSTRUCTIONS:

You may use the following constants:
Density of the earth, $\rho = 5.51 \times 10^3 kg/m^3$
Gravitational constant $G = 6.67 \times 10^{-11} Nm^2/kg^2$
Gravitational acceleration, $g = 10 m/s^2$
Answer Question ONE and ANY Other TWO Questions.

QUESTION ONE

a) Using the kinematics of Simple Harmonic motion show that $\omega = 2\pi f$ (5 marks)

b) Using the equation of simple harmonic motion derive the equation for the velocity and acceleration of the a particle in simple harmonic motion in terms of velocity and acceleration amplitudes. (6 marks)

c) The force acting on a particle in simple harmonic motion oscillator is given by the expression

$F = -kx\hat{i}$

i.) Prove that the force is conservative (2 marks)

ii.) Find the potential energy of the oscillator (3 marks)

d) A coupled oscillator has two equal masses m connected by springs having equal spring constants k as shown in the figure below.

The masses are free to slide on a frictionless table AB. The walls A and B to which the ends of the springs are attached are fixed

i.) Set up the differential equations for the motion (5 marks)

ii.) Find the normal frequency for the system (4 marks)

e) State the three Keplers laws of planetary motion (3 marks)

f) Determine the force between two electrons separated by a distance of 0.1mm (3 marks)

QUESTION TWO

a) Derive the formulae for the period of a simple pendulum (8 marks)

b) A 200-g block connected to a light spring for which the force constant is 5.00 N/m is free to oscillate on a horizontal, frictionless surface. The block is displaced 5.00 cm from equilibrium and released from rest. Compute:

i) The period of its motion (3 marks)

ii) The maximum velocity of the block (3 marks)

iii) Express the position, speed and acceleration as a function of time (6 marks)

QUESTION THREE

a) Show that for a spring in simple harmonic motion the period of oscillation is given by equation $T = 2\pi\sqrt{\frac{m}{k}}$ (8 marks)

b) The equation of a wave as time dependent along the x-direction is given by $x(t) = 4.00Cos(\pi t + 0.25\pi)$. Determine:

i.) The amplitude (1 mark)

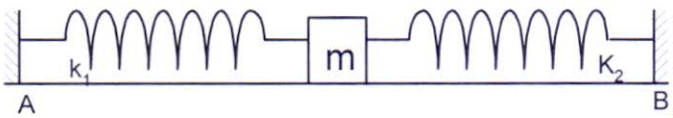
ii.) The frequency f of the vibrating particles (3 marks)

iii.) The phase and the Phasor when t=1sec (2 marks)

iv.) Calculate the velocity and the acceleration of the wave at any time. (6 marks)

QUESTION FOUR

a) The figure below shows a mass m which is on a frictionless table connected to fixed points A and B by two springs of natural length, of negligible mass and spring constants K_1 and K_2 respectively.



The mass m is displaced horizontally and then released. Prove that the period of oscillation is given by the equation $T = 2\pi\sqrt{\frac{m}{k_1 + K_2}}$ (7 marks)

b) On the same axes sketch a graph of potential energy, kinetic energy and the total mechanical energy of a particle in simple harmonic motion for one complete oscillation. (5 marks)

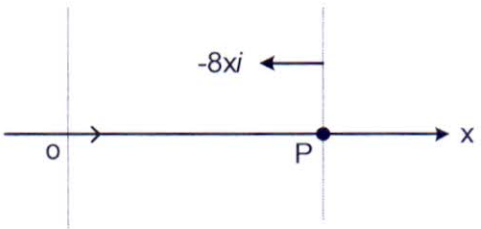
c) A 0.5kg cart connected to a light spring for which the force constant is 20.0N/M oscillates on a horizontal frictionless air track.

i.) Calculate the total energy of the system and the maximum speed of the cart if the amplitude of the motion is 3.00cm (5 marks)

ii.) What is the velocity of the cart when the position is 2.00cm ? (3 marks)

QUESTION FIVE

a) A particle of mass 2 moves away along the x axis attracted towards origin O by a force whose magnitude is equal to 8x as shown in the figure below.



If it is initially at rest, at x=20 find:

i.) The differential equations and the initial conditions describing the motion of the particle (3 marks)

ii.) The position of the particle at any time (3 marks)

iii.) The speed and the velocity of the particle at any time (4 marks)

iv.) The amplitude, period and frequency of the vibration (4 marks)

b) Suppose that the particle P in question 5a) above also has a damping force whose magnitude is numerically equal to 8 times the instantaneous speed, find the position and the velocity of the particle at any time. (6 marks)

--END--