KISII UNIVERSITY

UNIVERSITY EXAMINATIONS

SPECIAL EXAMINATION

THIRD YEAR EXAMINATION FOR THE AWARD OF THE DEGREEOF BACHELOR OF EDUCATION (SCIENCE)

FIRST SEMESTER 2021/2022

(JULY, 2022)

PHYS 311: MECHANICS AND PARTICLE DYNAMICS II

STREAM: Y3 S1 **TIME: 2 HOURS**

DAY: FRIDAY, 8:00 AM – 10:00 AM **DATE: 22/07/2022**

INSTRUCTIONS:

1. ***Do not write anything on this question paper.***
2. ***Answer Question ONE (Compulsory) and any other TWO questions.***

QUESTION ONE

(i) Damping can be under damped, over damped or critically damped. Give a brief explanation of each. (3marks)

(ii) A block on spring with k=0.75Nm^{-1}has the equation of motion $\ddot{x}+4.64\dot{x}+3.25x=0$. Find the mass m of the block and the damping constant b including units. Determine whether the system is underdamped, critically damped or underdamped. (4marks)

(iii) In case of mechanical oscillators, three conditions must be satisfied for the occurrence of simple harmonic oscillations. State the conditions. (6marks)

(iv) State the three elements of simple harmonic motion. (3marks)

(v) Define resonance as used in driven motion. (2marks)

(vi) State the principle of superposition. (2marks)

(vii) Explain the effect of friction in the mass-spring system. (2marks)

(viii) If $x_1=10\cos wt$ and $x_2=5\cos(wt+2)$, find the resultant shm. (4marks)

(ix) Since the earth is rotating, show that the measured free fall is less than the gravitational acceleration. (4marks)

QUESTION TWO

i) For the damped oscillator whose mass, m=250g, stiffness, k=85N/m, damping factor, c=70g/s.
   (a) What is the period of the motion? (5marks)
   (b) How long does it take for the amplitude of the damped oscillations to drop to half its initial value? (5marks)

ii) Differentiate between homogeneous and non homogeneous linear differential equations. (4marks)

iii) Solve the differential equation $\ddot{x} + x = 2\dot{x}$ with initial conditions x(0)=1, x(1)=0 (6marks)

QUESTION THREE

(i) A mass m is at the end of a spring of stiffness k. Show that by considering forces acting:
   (a) ky=mg (static case); y=displacement (5marks)
   (b) m ÿ=-ke-ky+mg (dynamic case); e=extension for dynamic case (5marks)
   (c) Hence, the equation of motion is mÿ +ky=0 (2marks)
   (d) w=$\sqrt{k/m}$ Where w is the angular velocity (3marks)

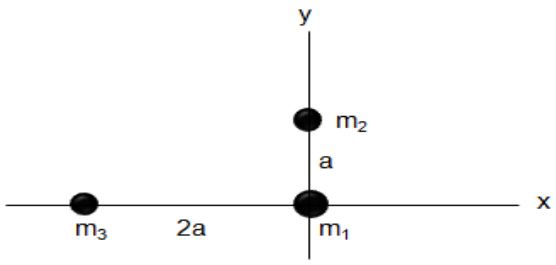
(ii) Solve the following non-homogeneous linear differential equation

$$\ddot{x} + 2\dot{x} + 5x = cos2t$$ (5marks)

QUESTION FOUR

(i) State Newton's law of gravitation. (2marks)

(ii) The figure below shows an arrangement of three particles, particle 1 having mass m_1=6.0kg and particle 2 and 3 having mass m_2=m_3=4.0kg and with distance a =2.0cm.What is the net gravitational force F_1 that acts on particle 1 due to the other particles? (G=6.67x10^{-11}m/Kg.s) (6marks)



(iii) Show the relationship between gravitational force, F and gravitational acceleration, a_g . (3marks)

(iv) What are the assumptions made in the measure of the gravitational acceleration, a_g. (3marks)

(v) Explain Kepler's laws as applied to planets orbiting the sun. (6marks)

QUESTION FIVE

(i) An undamped system consists of a mass which weighs 50N and a spring stiffness 4000N/m. If its acted upon by a harmonic force of amplitude 60N and frequency of 6Hz. Find:

(a) The displacement of the spring due to the weight of the mass. (4marks)

(b) Static displacement of the spring due to the maximum applied force. (4marks)

(c) The amplitude of the forced motion of the mass. (4marks)

(d) List two applications of resonance in really life. (2marks)

(ii) List any dampers that limit harmonic motion in really life. (3marks)

(iii) Explain three applications of harmonic motion in really life situation. (3marks)