UNIVERSITY OF NAIROBI

DEPARTMENT OF PHYSICS

SPH 201: MECHANICS II

Problem Set 2 – Dampled Oscillatory

Submit ANY ONE SOLUTION FROM EACH CATEGORY

A. Damped Oscillatory motion

1. A particle P of mass 2 moves along the x-axis attracted towards the origin by a force of magnitude 10x. If the particle has a damping force 4 times the instantaneous speed and has a displacement of x = 5 and velocity v = $-3ms^{-1}$ at time t = 0, determine
   (i) The differential equation of motion
   (ii) The position of the particle at any time
   (iii) The amplitude & period T of the motion
   (ii) Illustrate graphically the position of P as function of time.
   (iii) Give a physical interpretation of your results

2 A 1.5 Kg mass hung on a vertical spring stretches it 0.4 m. The mass is the pulled down 1m and released. Determine.
   (i) The position of the mass at any time if a damping force of magnitude 15 times the instantaneous speed is acting.
   (ii) The period T of the motion.
   (iii) if the motion is oscillatory damped, overdamped or critically damped.

B. Forced Oscillatory motion

1. A vertical spring has a stiffness factor of 48N/m. At t = 0, a force given by *F(t) = 51 sin 3t*, t ≥ 0 is applied to a mass of 3Kg which hangs in equilibrium at the end of the spring. Neglecting damping, Determine
   (i) The differential Equation of motion
   (ii) The position of the mass at any later time t
   (iii) From your solution in (ii) above, explain what would happen to the system when the forced frequency equals the natural frequency of the oscillator.

2 The position of a particle moving along the x-axis is determined by the equation $\frac{d^2x}{dt^2} + 8x = 20\cos 2t$. If the particle starts from rest at x = 0, determine
   (i) The position x as a function of time

(ii) The amplitude, period and frequency of the oscillation after a long time has elapsed

3. The weight of a vertical spring undergoes forced vibrations according to the equation $\frac{d^2x}{dt^2} + 4x = 8\sin \omega t$ where x is the displacement from the equilibrium position and $\omega > 0$. If at t = 0, x = 0 and $\frac{dx}{dt} = 0$, determine

(i) The position x as a function of t,

(ii) The period of the external force for which resonance occurs.
