INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH103 : Physics
Tutorial 9

1. For a gigantic overdamped harmonic oscillator (as shown in figure below), natural frequency ω_0 is given as 10 rad/s and damping parameter $\gamma = 20/$s. The initial conditions of the oscillator are $x(0) = -20m$ and $v(0) = -600m/s$.
   (a) Using the initial conditions, obtain the constants A and B in the solution of over damped oscillator as mentioned in the class
   (b) Will the system cross equilibrium at finite time?
   (c) Plot $x(t)$ v/s t.

Figure 1: The gigantic damped oscillator

2. Show that for the case of over damped oscillator $\frac{dx(t)}{dt}$ varies linearly with $x(t)$ when $t \to \infty$?

3. Consider a driven damped oscillator, with $\gamma \ll \omega_0$, where ω_0 is the natural frequency and damping parameter is given as γ . Show that when the driving frequency ω_d becomes equal to $\omega_{res} \pm \gamma$ the amplitude $A(\omega_d) = \frac{A_{max}(\omega_{res})}{\sqrt{2}}$, where ω_{res} is the resonance frequency.

4. For a driving force $F(t) = A \cos \omega_d t$, the solution of the driven damped oscillator is assumed to be $x(t) = A\cos(\omega_d t + \phi)$. Under what condition of ϕ, velocity of this driven damped oscillator becomes exactly in phase with the driving force?.