



INDIAN INSTITUTE OF TECHNOLOGY PATNA  
DEPARTMENT OF PHYSICS

Tutorial 8

PH103

19/02/21

1

For a gigantic overdamped harmonic oscillator (as shown in figure below), natural frequency  $\omega_0$  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

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

3

Consider a driven damped oscillator, with  $\gamma \ll \omega_0$ , where  $\omega_0$  is the natural frequency and damping parameter is given as  $\gamma$ . Show that when the driving frequency  $\omega_d$  becomes equal to  $\omega_{res} \pm \gamma$  the amplitude  $A(\omega_d) = \frac{A_{max}(\omega_{res})}{\sqrt{2}}$ , where  $\omega_{res}$  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  $\phi$ , velocity of this driven damped oscillator becomes exactly in phase with the driving force?.