INDIAN INSTITUTE OF TECHNOLOGY

PH103 PHYSICS

TUTORIAL 7 for G1 to G6

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.

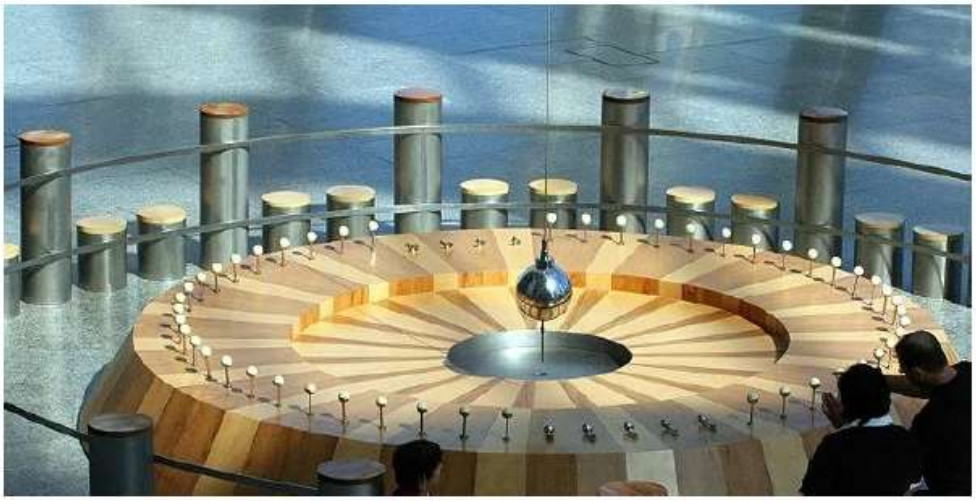


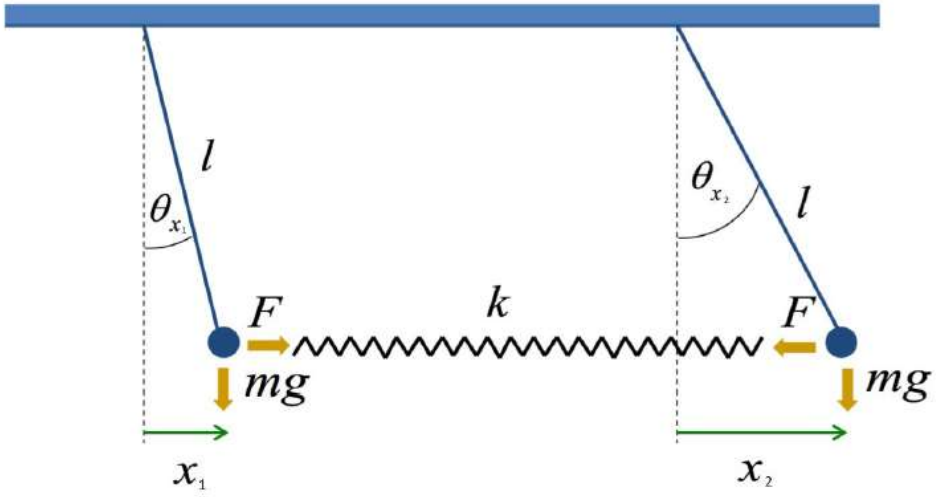
Figure 1: The gigantic damped oscillator

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

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

4

Consider two pendula which are coupled together with a spring having a constant k as shown in figure below. Assume that the equilibrium positions are small enough that small angle approximation could be used. Find the normal modes and normal co-ordinates for this system?



5

Consider 2 masses connected via springs which has constants k. Assume this coupled oscillator is immersed in a fluid so that both masses feel a damping force, $F_f = -bv$. Solve for $x_1(t)$ and $x_2(t)$. Assume underdamping.

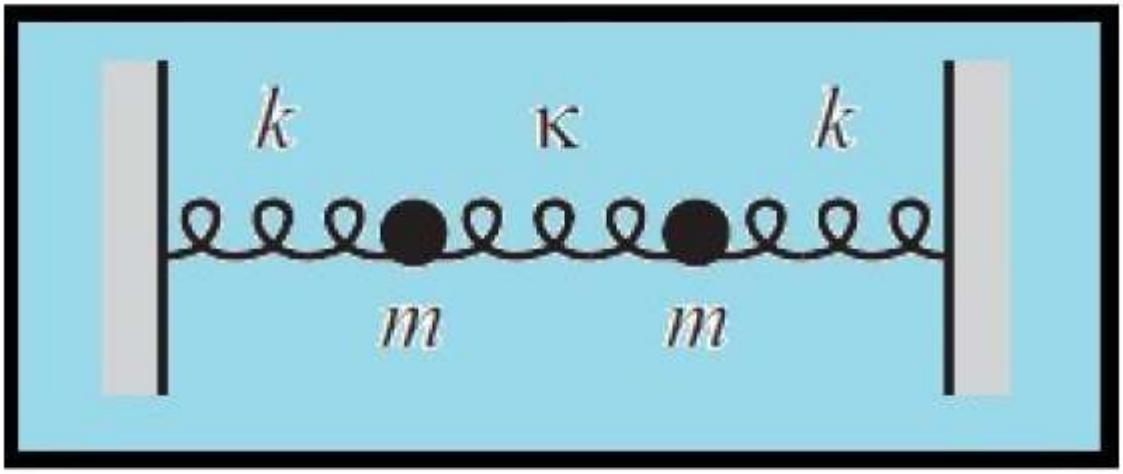


Figure 3: Damped coupled oscillator