

**Physics I**  
**ISI B.Math**  
**HW set 3**  
**Total Marks = 30**

1. an overdamped harmonic oscillator satisfies the equation

$$\ddot{x} + 10\dot{x} + 16x = 0$$

At time  $t = 0$ , the particle is projected from the point  $x = 1$  toward the origin with speed  $u$ . Find  $x(t)$ . Show that the particle will reach the origin at some later time  $t$  if

$$\frac{u - 2}{u - 8} = e^{6t}$$

How large must  $u$  be so that the particle will pass through the origin? (10)

2. A child of mass  $m$  sits in a swing of negligible mass suspended by a rope of length  $l$ . Assume that the dimensions of the child are negligible compared to  $l$ . His father pulls him back until the rope makes an angle of 1 radian with the vertical, then pushes with a force  $F = mg$  along the arc of a circle of radius  $l$  until the rope is vertical, and releases the swing. For what duration of time did the father push the swing? You may assume  $\sin \theta \approx \theta$  for  $\theta < 1$  (10)

4. A partially damped oscillator satisfies the equation

$$\ddot{x} + 2\kappa\dot{x} + \Omega^2 x = 0$$

$\Omega$  is a positive constant and  $\kappa$  is given by  $\kappa = 0, x < 0$ ,  $\kappa = K, x > 0$  where  $K$  is a positive constant such that  $K < \Omega$ . Find the period of oscillation and the ratio of successive maximum values of  $x$ . (10)