

## Non linear dynamics(PH4104/PH5104) Mid Sem Exam

time 1hr

1. Find out the fixed points, stability of fixed points from linearization and draw the phase portrait in (x,y plane) of following equations:

$$\dot{x} = x(1 - x^2) \quad \dot{y} = -y$$

(2+4+2)

2. Consider the equation  $\dot{x} = \cosh(x) - h$ . Show that it undergoes a bifurcation as the constant  $h$  is increased from zero. Find out the (a)critical value of  $h$ , (b)fixed points and (c)the nature of the bifurcation. Draw the (d)flow before and after the bifurcation and from that (e)comment on the stability of the fixed points. When  $h < h_c$ , (f) obtain the time taken  $T$  to move from  $-\infty$  to  $\infty$  and (g) leading order behavior of  $T$  in terms of  $h_c - h$  close to the bifurcation ( $|h_c - h| \ll 1$ ).

(1+2+1+2+2+3.5+0.5)

Mathematical formula:  $\cosh(x) = (e^x + e^{-x})/2$

