Modern Control System   **Non-Linear System & Linearization**

1. Describe the process of linearization by small signal analysis.
2. Linearize following non-linear equation with equilibrium state $x_0=0$

$$\dot{x} = x_2$$
$$\dot{x}_2 = \mu(1 - x^2)x_2 - x_1 \qquad\qquad \mu > 0$$

Also check its stability

3. The state equation of a nonlinear system are given below. Determine all points of equilibrium and investigate the stability in the neighbourhood of these points

$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = -x_1^2 - x_2^2 - 2x_1 - 2x_2$$

4. Derive the describing function of following
   a. Ideal relay
   b. Practical relay
   c. Combination of dead zone and saturation
   d. Backlash
5. How stability is decided by describing function method?
6. Determine stability of following system by describing function method. The describing

function of nonlinearity is given by $G(x)_D = \dfrac{2K}{\pi}\left[Sin^{-1}\dfrac{s}{X} + \dfrac{s}{X}\sqrt{1 - \left(\dfrac{s}{X}\right)^2}\right]$