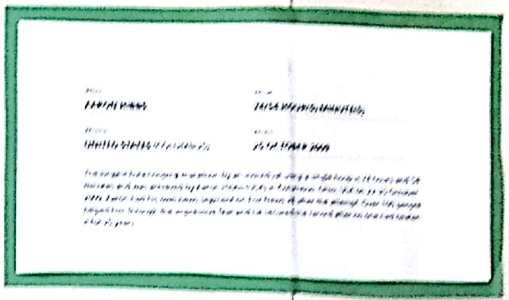
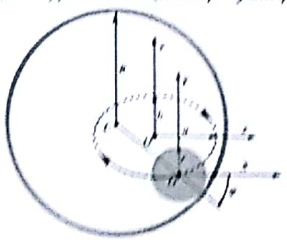
HULA HOOP



$$I_z\ddot{\theta} + k\dot{\theta} = -F_f R \qquad (1)$$

$$m(R-r)\ddot{\varphi} = m(\ddot{x}\sin\varphi + \ddot{y}\cos\varphi) + F_f \qquad (2)$$

$$m(R-r)\dot{\varphi}^2 = N + m(\ddot{x}\cos\varphi - \ddot{y}\sin\varphi) \qquad (3)$$



1. A hula hoop with the radius R twisting with the angle φ around a circular waist (pipe) with the radius r. The center O' of the waist moves along the elliptic curve $x = a\cos\omega t$, $y = b\cos\omega t$ with the fixed center O.