1) $\underline{I}_c^{\text{an.}} = (mR^2, mR^2, 2mR^2)$

$\underline{I}_c^{\text{asta I}} = \left(0, \frac{mR^2}{3}, \frac{mR^2}{3}\right)$ $\qquad$ $\underline{I}_c^{\text{asta II}} = \left(\frac{mR^2}{3}, 0, \frac{mR^2}{3}\right)$

$\underline{I}_c^{\text{tot.}} = \underline{I}_c^{\text{an.}} + \underline{I}_c^{\text{asta I}} + \underline{I}_c^{\text{asta II}} = \left(\frac{4}{3}mR^2, \frac{4}{3}mR^2, \frac{8}{3}mR^2\right)$

2) $T = \frac{1}{2}M v_P^2 + \frac{1}{2}4m v_c^2 + \frac{1}{2}\bar{\omega}\cdot\underline{I}_c^{\text{tot.}}(\bar{\omega})$

$v_P^2 = \dot{q}^2 \qquad \bar{\omega} = -\frac{\dot{s}}{R}\bar{K}_3$ (condiz. di rotolamento)

$\bar{x}_c = \frac{1}{\sqrt{2}}(s+R)\bar{e}_1 - \frac{1}{\sqrt{2}}(s-R)\bar{e}_2 \qquad \bar{v}_c = \frac{1}{\sqrt{2}}\dot{s}\bar{e}_1 - \frac{1}{\sqrt{2}}\dot{s}\bar{e}_2 \qquad v_c^2 = \dot{s}^2$

$T = \frac{1}{2}M\dot{q}^2 + m\dot{s}^2 + \frac{4}{3}m\cancel{R^2}\frac{\dot{s}^2}{\cancel{R^2}} = \frac{1}{2}M\dot{q}^2 + \frac{7}{3}m\dot{s}^2$

$V = \frac{k}{2}(P-C)^2 + 4mgy_c$

$P-C = (P-O) - (C-O) = q\bar{e}_1 - \frac{1}{\sqrt{2}}(s+R)\bar{e}_1 + \frac{1}{\sqrt{2}}(s-R)\bar{e}_2$

$(P-C)^2 = \frac{1}{2}(s^2+R^2+\cancel{2sR}) + q^2 - \sqrt{2}q(s+R) + \frac{1}{2}(s^2 - \cancel{2sR} + R^2) = s^2 + q^2 + R^2 - \sqrt{2}q(s+R)$

$V = \frac{k}{2}(s^2+q^2-\sqrt{2}qs - \sqrt{2}Rq) - 2\sqrt{2}mgs + \text{cost.}$

$L = T - V = \frac{1}{2}M\dot{q}^2 + \frac{7}{3}m\dot{s}^2 - \frac{k}{2}(s^2+q^2-\sqrt{2}qs-\sqrt{2}Rq) + 2\sqrt{2}mgs$

eq. Lagrange $\quad M\ddot{q} + kq - \frac{\sqrt{2}}{2}ks - \frac{\sqrt{2}}{2}kR = 0$

$\frac{14}{3}m\ddot{s} + ks - \frac{\sqrt{2}}{2}kq - 2\sqrt{2}mg = 0$

3) $\begin{cases} \frac{\partial V}{\partial s} = ks - \frac{k}{\sqrt{2}}q - 2\sqrt{2}mg = 0 \\ \frac{\partial V}{\partial q} = kq - \frac{k}{\sqrt{2}}s - \frac{kR}{\sqrt{2}} = 0 \end{cases}$ $\qquad s = R + 4\sqrt{2}\frac{mg}{k}$, $\quad q = \sqrt{2}R + 4\frac{mg}{k}$

$\frac{\partial^2 V}{\partial s^2} = k > 0 \qquad \frac{\partial^2 V}{\partial q^2} = k > 0 \qquad \frac{\partial^2 V}{\partial q\partial s} = -\frac{k}{\sqrt{2}} \qquad \det H = \frac{k^2}{2} > 0$

l'equilibrio è stabile

4) $M\bar{a}_P = M\bar{g} + k(C-P) + \bar{\phi}_P$