$T = \frac{1}{2} m v_C^2 + \frac{1}{2}\frac{m}{2} v_P^2$

$\overline{OC} = -(s+R)\,\bar{e}_2 \qquad \overline{OP} = -(s+R+R\cos\theta)\,\bar{e}_1 + R\sin\theta\,\bar{e}_2$

$\bar{v}_C = -\dot{s}\,\bar{e}_2 \qquad \bar{v}_P = (-\dot{s} + R\sin\theta\,\dot\theta)\,\bar{e}_1 + R\cos\theta\,\dot\theta\,\bar{e}_2 \qquad v_P^2 = \dot{s}^2 + R^2\dot\theta^2 - 2R\sin\theta\,\dot{s}\dot\theta$

$T = \frac{m}{2}\left(\frac{3}{2}\dot{s}^2 + \frac{1}{2}R^2\dot\theta^2 - R\sin\theta\,\dot{s}\dot\theta\right)$

$V = \frac{k}{2}|\overline{OA}|^2 + \frac{h}{2}|\overline{DP}|^2 + mg\,y_C + \frac{m}{2}g\,y_P - F x_P$

$= \frac{mg}{R}s^2 + \frac{mg}{2R}R^2\left(\frac{5}{4} - \cos\theta\right) - mg(s+R) - \frac{mg}{2}(s+R+R\cos\theta) - mgR\sin\theta$

$= mg\left(\frac{s^2}{R} - \frac{3}{2}s - R\cos\theta - R\sin\theta\right) + \text{cost}$

$L = T - V$

$\frac{3}{2}\ddot{s} - \frac{1}{2}R\sin\theta\,\ddot\theta - \frac{1}{2}R\cos\theta\,\dot\theta^2 - \frac{2g}{R}s - \frac{3}{2}g = 0$

$\frac{1}{2}R^2\ddot\theta - \frac{1}{2}R\sin\theta\,\ddot{s} - gR\sin\theta + gR\cos\theta = 0$

$\frac{\partial V}{\partial s} = mg\left(\frac{2s}{R} - \frac{3}{2}\right) = 0 \qquad s = \frac{3}{4}R$

$\frac{\partial V}{\partial \theta} = mgR(\sin\theta - \cos\theta) = 0 \qquad \operatorname{tg}\theta = 1 \qquad \theta = \frac{\pi}{4}, \frac{3\pi}{4}$

$\frac{\partial^2 V}{\partial s^2} = \frac{2mg}{R} \qquad \frac{\partial^2 V}{\partial \theta^2} = mgR(\cos\theta + \sin\theta) \qquad \frac{\partial^2 V}{\partial s\partial\theta} = 0$

$\frac{\partial^2 V}{\partial s^2} > 0$ sempre $\qquad H\left(\frac{\pi}{4}\right) = \sqrt{2}\,m^2g^2 > 0$ stabile $\qquad H\left(\frac{3\pi}{4}\right) = -\sqrt{2}\,m^2g^2 < 0$ inst.

Piccole oscillazioni in $s = \frac{3}{4}R$, $\theta = \frac{\pi}{4}$

$T \sim \frac{m}{2}\left(\frac{3}{2}\dot{s}^2 + \frac{1}{2}R^2\dot\theta^2 - \frac{\sqrt{2}}{2}R\dot{s}\dot\theta\right)$

$A = \begin{pmatrix} \frac{3}{2}m & -\frac{\sqrt{2}}{4}mR \\ -\frac{\sqrt{2}}{4}mR & \frac{1}{2}mR^2 \end{pmatrix} \qquad C = \begin{pmatrix} \frac{2mg}{R} & 0 \\ 0 & \sqrt{2}\,mgR \end{pmatrix}$

$\frac{5}{8}\cancel{m^2}R^2\lambda^2 - \left(1 + 3\frac{\sqrt{2}}{2}\right)\cancel{m^2}Rg\,\lambda + 2\sqrt{2}\,\cancel{m^2}g^2 = 0$

$\frac{m}{2}\bar{g} + \bar{F} + h\overline{PD} + \bar\phi_P = 0 \qquad \bar\phi_P = \frac{mg}{2}\bar{e}_2 - mg\bar{e}_1 + \frac{mg}{R}R\left(\sin\theta\,\bar{e}_1 + \left(\frac{1}{2} - \cos\theta\right)\bar{e}_2\right)$

$\bar\phi_P = mg\left[\left(\frac{\sqrt{2}}{2} - 1\right)\bar{e}_1 + \left(1 - \frac{\sqrt{2}}{2}\right)\bar{e}_2\right] = \left(\frac{\sqrt{2}}{2} - 1\right)mg\,(\bar{e}_1 - \bar{e}_2)$