1)

$BC = \sqrt{2}R$

$A^{(T)} = \frac{3\sqrt{3}}{4}R^2 \qquad A^{(C)} = \pi R^2 \qquad A^{(L)} = A^{(C)} - A^{(T)} = \frac{4\pi - 3\sqrt{3}}{4}R^2$

$m^{(T)} = \frac{A^{(T)}}{A^{(L)}}m = \frac{3\sqrt{3}}{4\pi - 3\sqrt{3}}m \qquad m^{(C)} = \frac{A^{(C)}}{A^{(L)}}m = \frac{4\pi}{4\pi - 3\sqrt{3}}m$

$I_{G\,ij}^{(C)} = m^{(C)}\,\mathrm{diag}\left(\frac{R^2}{4}, \frac{R^2}{4}, \frac{R^2}{2}\right)$

$I_{H\,ij}^{(T)} = m^{(T)}\,\mathrm{diag}\left(\frac{3}{8}R^2, \frac{R^2}{8}, \frac{R^2}{2}\right)$

$I_{G\,ij}^{(T)} = I_{H\,ij}^{(T)} - m^{(T)}\,\mathrm{diag}\left(\frac{R^2}{4}, 0, \frac{R^2}{4}\right) = m^{(T)}\,\mathrm{diag}\left(\frac{R^2}{8}, \frac{R^2}{8}, \frac{R^2}{4}\right)$

$I_{G\,ij}^{(L)} = I_{G\,ij}^{(C)} - I_{G\,ij}^{(T)} = \frac{8\pi - 3\sqrt{3}}{4\pi - 3\sqrt{3}}\frac{mR^2}{8}\,\mathrm{diag}(1,1,2)$

2) $T = \frac{m}{2}\dot{s}^2 + \frac{1}{2}I_{G\,33}^{(L)}\dot{\theta}^2 \qquad \dot{\theta} = \frac{\dot{s}}{R} \qquad \theta = \frac{s}{R}$

$T = \frac{1}{2}(m+\mu)\dot{s}^2 \qquad$ dove $\mu = I_{G\,33}^{(L)}/R^2 = \frac{8\pi - 3\sqrt{3}}{4\pi - 3\sqrt{3}}\frac{m}{4}$

$V = \frac{k}{2}(0-s)^2 - \bar{F}\cdot\bar{x}_A \qquad \bar{x}_A = (s + R\sin\theta)\bar{e}_1 + R(1-\cos\theta)\bar{e}_2$

$V = \frac{k}{2}(s^2 + R^2) - F\left(s + R\sin\frac{s}{R}\right)$

$L = T - V = \frac{1}{2}(m+\mu)\dot{s}^2 - \frac{k}{2}s^2 + Fs + FR\sin\frac{s}{R}$

$\frac{d}{dt}\frac{\partial L}{\partial \dot{s}} - \frac{\partial L}{\partial s} = (m+\mu)\ddot{s} + ks - F\left(1 + \cos\frac{s}{R}\right) = 0$

3) $H = T + V = \frac{1}{2}(m+\mu)\dot{s}^2 + \frac{k}{2}s^2 - Fs - FR\sin\frac{s}{R}$

$H(0) = \frac{1}{2}(m+\mu)c^2 = \frac{1}{2}(m+\mu)\dot{s}^2(s=\pi R) + \frac{k}{2}\pi^2R^2 - F\pi R$

$\dot{s}(s=\pi R) = \sqrt{c^2 + \frac{2\pi R}{m+\mu}\left(F - \frac{k\pi R}{2}\right)}$

4) $m\bar{a}_G = m\bar{g} + \bar{F} - k(G-O)$

$m\ddot{s}\,\bar{e}_1 = -mg\bar{e}_2 + F\bar{e}_1 - ks\,\bar{e}_1 - kR\bar{e}_2 + \bar{\phi}$

$\bar{\phi} = (m\ddot{s} - F + ks)\bar{e}_1 + (mg + kR)\bar{e}_2 = \left(\frac{\mu}{m+\mu}(ks - F) + \frac{m}{m+\mu}F\cos\frac{s}{R}\right)\bar{e}_1 + (mg + kR)\bar{e}_2$