Lab-Project 2 Slender Bar

The ends of a homogeneous slender bar (mass m, length ℓ) are guided in vertical and horizontal direction as shown in the sketch. The left end is connected to a spring (stiffness k) which is un-stretched when the elongation angle $\theta = 0$.
Neglecting friction, determine:

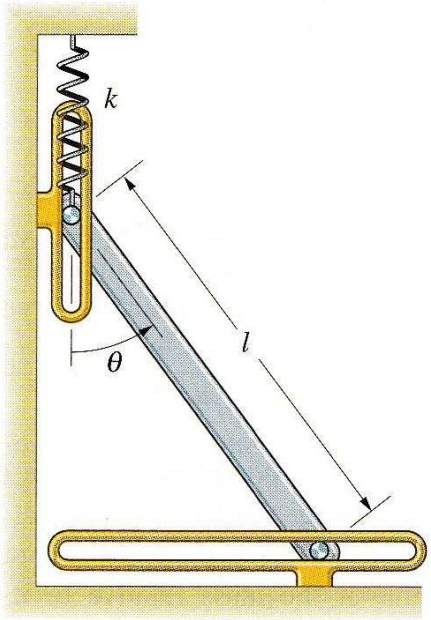
a) the nonlinear motion equation of the bar via LAGRANGE method of 2nd kind,

b) the equilibrium positions (all),

c) the linearized motion equation respecting one nontrivial equilibrium position,

d) the eigen-frequency ω of the small motions related to the chosen equilibrium position.

e) the amplitude of the linearized motion for the given parameters and initial conditions:



$$
\begin{array}{lcll}
m & = & 1.5 & kg \\
g & = & 9.81 & m/s^2 \\
L & = & 0.3 & m \\
k & = & 100 & N/m \\
t_0 & = & 0 & [s] \\
\theta(t_0) & = & 0.25 & [\text{rad}] \\
\dot{\theta}(t_0) & = & 0.1 & [\text{rad}/s]
\end{array}
$$

f) the plot of time history $\theta(t)$ for $t \in [0 : 8\pi/\omega]$.