Contents


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% Joel Lubinitsky - 02/18/15
% MAE 321 - HW 5.1

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Problem 1:

Use Lagrange's formulation to calculate the equation of motion and the natural frequency of the system of Figure P1.76. Model each of the brackets as a spring of stiffness k, and assume the inertia of the pulleys is negligible.

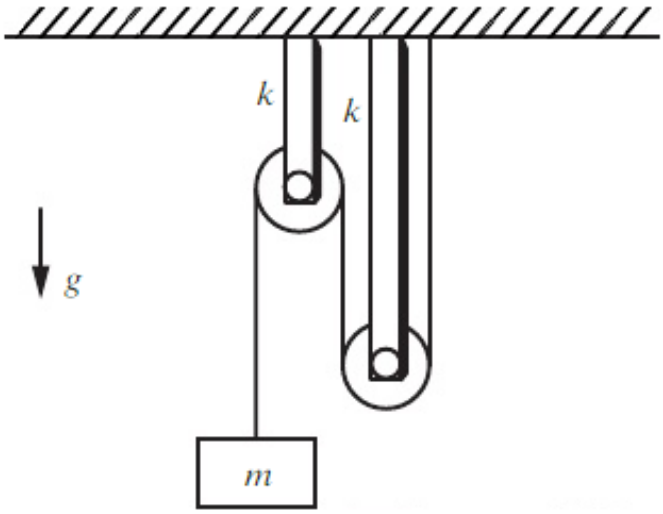

Figure P1.76

Unknown: EoM, ω_n

Calculations

Due to geometry of system, displacement of pulleys must be $\frac{1}{4}$ the displacement of the mass. With this relation, total kinetic and potential energy are

$$T = \frac{1}{2}m\dot{x}^2$$

$$U = \frac{1}{2}k\frac{x}{4}^2 + \frac{1}{2}k\frac{x}{4}^2 = \frac{1}{16}kx^2$$

$$L = T - U = \frac{1}{2}m\dot{x}^2 - \frac{1}{16}kx^2$$

$$\frac{d}{dt}(\frac{\partial L}{\partial \dot{x}}) - \frac{\partial L}{\partial x} = 0$$

$$m\ddot{x} + \frac{1}{8}kx = 0$$

$$\ddot{x} + \frac{k}{8m}x = 0$$

ω_n^2 is the coefficient of the displacement, so

$$\omega_n = \sqrt{\frac{k}{8m}}$$

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