
Vibrations and Dynamics - 1

A pendulum is connected to a spring as shown in the figure below and is displaced an angle θ . Ignore the mass of the rod of the pendulum and assume the spring deflects only horizontally and;

- 1) Draw the free body diagram of the system. **(20 points)**
- 2) Derive the equation of motion of the system. **(20 points)**
- 3) Assuming small angular rotation θ of the pendulum, derive the linear equation of motion of the system. **(20 points)**
- 4) Derive an expression for the natural frequency of the pendulum. **(20 points)**
- 5) If the spring stiffness k is set to zero, calculate the natural frequency for a pendulum length $l = 250\text{mm}$. **(20 points)**

Assume spring is always in the horizontal position.

