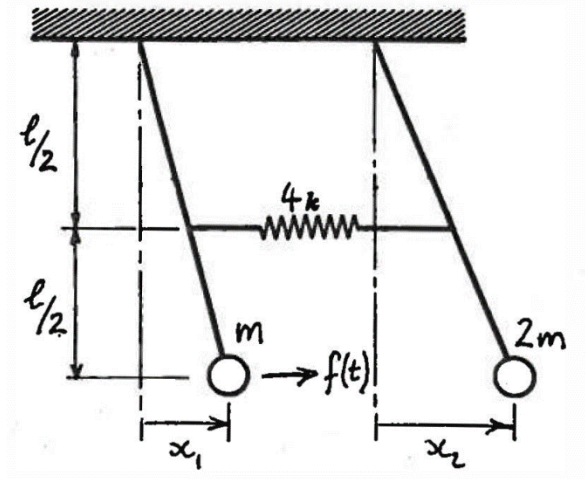


MECH 463 -- Homework 7

1. Two simple pendulums consist of very light, rigid rods of length ℓ , supporting masses m and $2m$, as shown in the diagram. The rods are pinned at their upper ends and they have a spring of stiffness $4k$ pinned at their midpoints. The spring is unstretched when the pendulums are vertical. A horizontal force $f(t) = F \cos(\omega_f t)$ acts on the mass m . Assume small vibrations.



- Draw a free body diagram of the system and derive the equations of motion in matrix form.
- Determine the natural frequencies and mode shapes of the system. Give physical interpretations of your results.
- Determine the response amplitudes X_1 and X_2 in terms of m , k , etc.
- Determine the excitation frequency ω_f at which the response amplitude X_1 is zero. Determine the corresponding response amplitude X_2 .

2. The diagram shows a very idealized 2-DOF model of an automobile. The body of the vehicle is represented as a beam of length ℓ , whose mass m is concentrated at its centre. The engine is represented as a concentrated mass m at one end of the beam. The front and rear suspensions are represented as springs of stiffness $3k$ and k respectively. The gearbox of the vehicle is damaged, and gives rise to a harmonic force $f(t) = F \cos(\omega_f t)$, acting at a point halfway between the two concentrated masses. Find the vibration amplitude /felt by the driver (assumed to be sitting at the centre of the beam). Give a physical explanation of any interesting features that you find.

