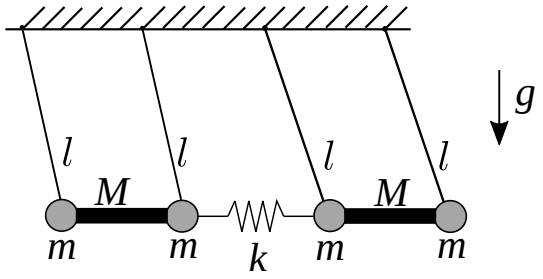
Homework 1: Equations of motion and eigenvalue problem



The given swing system consists of two pairs of pendulums connected by a spring with stiffness k. Each of the four pendulums has a length l and a bob with mass m. Additionally, each pair of pendulums is connected via a rigid platform with mass M.

Perform the following tasks, assuming small amplitude vibrations.

Tasks:

1. Identify the independent degrees of freedom for the given system.
2. Find the kinetic energy, potential energy and the Lagrangian of the system.
3. Using the Euler-Lagrange differential equation, find the equations of motion for the given system.
4. Find the eigenvalues and the normalized eigenvectors using the characteristic polynomial of the system.
5. Show if the eigenvectors found in task-4 are orthogonal or not. Explain why or why not they are orthogonal.
6. Implement the forward and inverse iteration algorithm in Matlab to find the eigenvalues and eigenvectors iteratively. Use a relative error criterion for convergence with a tolerance of 10^{-6}.
7. Using an initial guess of $\mathbf{x}_1 = [1 \quad 0]^T$, show that the forward iteration algorithm converges to the largest eigenvalue and vice versa for the inverse iteration. How many iterations did both algorithms take to converge?
8. Now use the vector $\mathbf{x}_1 = [1 \quad 1]^T$ as an initial guess in your forward itteration algorithm. Is it still converging to the largest eigen value? If not, explain why.

To solve tasks 4-8 use the following parameters:

$m = 25\ Kg$
$M = 700\ Kg$
$k = 3 \times 10^3\ N/m$
$l = 1\ m$
$g = 9.8\ m/s^2$

Note: The solution has to be submitted in hardcopy by **Monday, 3rd June,** in **IC-6/173**. Additionally, the Matlab files must be uploaded in moodle.