بسم الله الرحمن الرحيم

King Abdulaziz University
Engineering College
Department of MENG
4th Homework Assignment

Mechanical Vibrations
MENG 470
Spring 1425 H
Due Wed.: 29/1/1425 H

---

1) Consider the ODE of motion of 1-DOF system under damped free vibration:

$$\ddot{x} + 2\zeta\omega_n\dot{x} + \omega_n^2 x = 0\,, \qquad x(0) = 1 \qquad \dot{x}(0) = 1$$

a. For $\omega_n = 2$, $\zeta = 0.1$
Plot the solution for $0 < t < 10$.
Label the coordinates
b. For $\omega_n = 2$, plot the solution ($0 < t < 10$), for $\zeta = 0.1, 0.4$, and 0.99 on the same figure.
Label coordinates and denote each curve by its value of ζ.
c. Repeat (b) for $\zeta = 0.1, 0.4, 0.99, 2$, and 5.

2) A vibrating system consisting of a mass of 2.267 kg and a spring of stiffness 17.5 N/cm is viscously damped such that the ratio of any two consecutive amplitudes is 1.00 and 0.98. Determine:

a. The natural frequency of the damped system.
b. The logarithmic decrement.
c. The damping factor
d. The damping coefficient.

3) A vibrating system consists of a mass of 4.534 kg, a spring of stiffness 35.0 N/cm, and a dashpot with a damping coefficient of 0.1243 N/cm/s. Find:

a. The damping factor.
b. The logarithmic decrement.
c. The ratio of any two consecutive amplitudes.

4) A vibrating system has the following constants: m = 17.5 kg, k = 70.0 N/cm, and c = 0.70 N/cm/s. Determine:

a. The damping factor.
b. The natural frequency of damped oscillation.
c. The logarithmic decrement.
d. The ratio of any two consecutive amplitudes.

5) Set up the differential equation of motion for the system shown in Figure 1. Determine the expression for:

a. The critical damping coefficient
b. The natural frequency of damped oscillation.

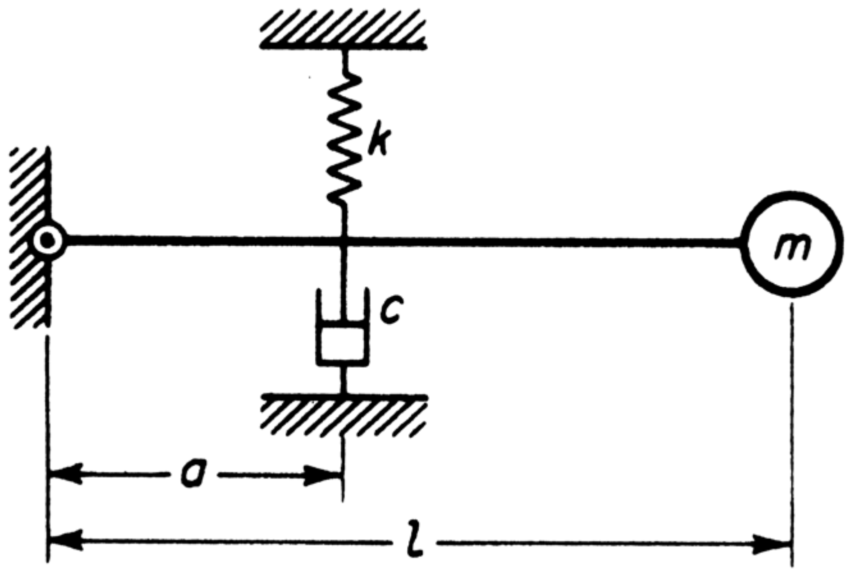

Figure 1

6) Write the differential equation of motion for the system shown in Figure 2 and determine the natural frequency of damped oscillation and the critical damping coefficient.

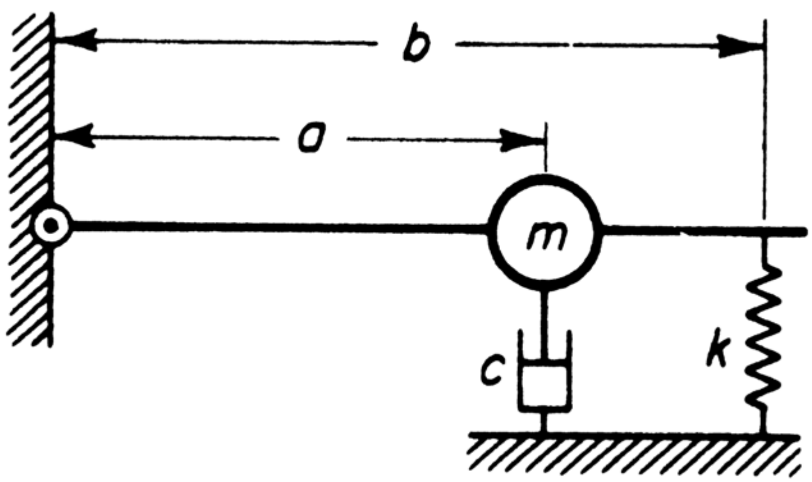

Figure 2

7) A spring-mass system with viscous damping is displaced from the equilibrium position and released. If the amplitude diminished by 5% each cycle, what fraction of the critical damping does the system have?

8) A rigid Uniform bar of mass m and length l is pinned at O and supported by a spring and viscous damper, as sown in Figure 3. Measuring θ from the static equilibrium position, Determine:

a) The equation for small θ (the moment of inertia of the bar about O is $ml^2/3$).
b) The equation for the undamped natural frequency.
c) The expression for critical damping. Use Virtual Work and D'Alembert's Principles.

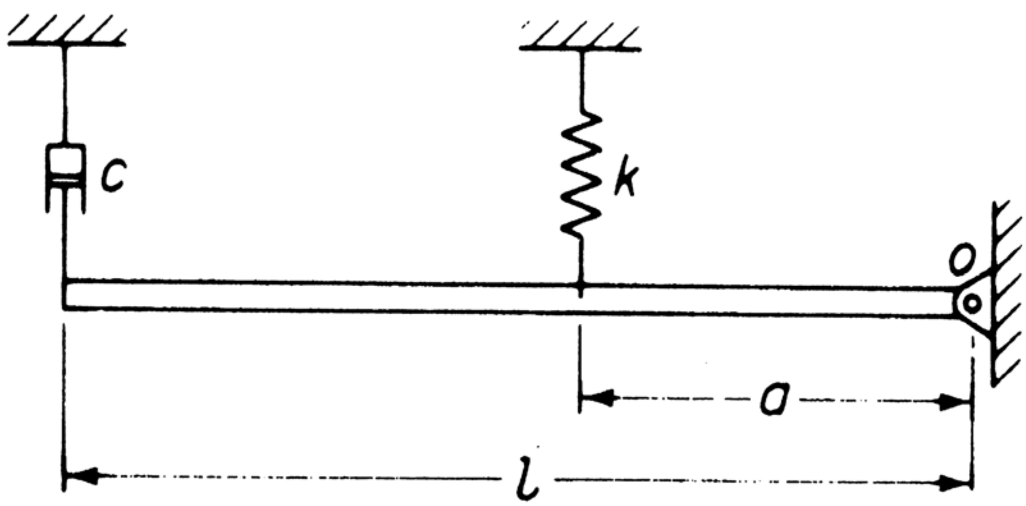

Figure 3