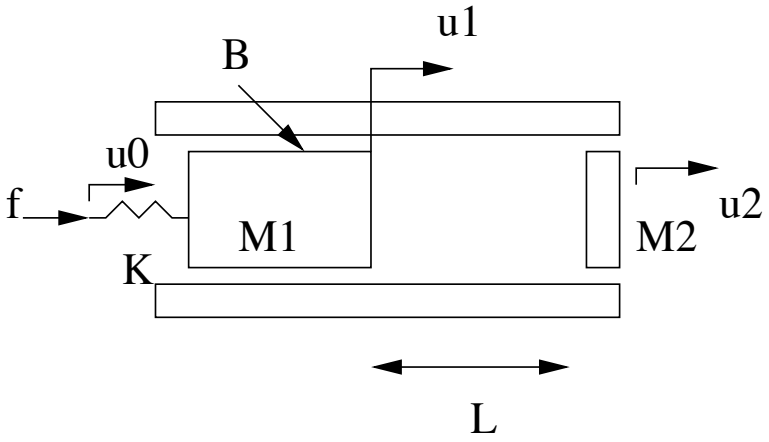
Department of Electrical and Computer Engineering
University of Massachusetts Lowell

EECE 4130 Problem Set #2

1.Consider the coupled acoustic-mechanical system. The velocity of the masses are given by u and applied force by the variable f. The variables k represent the mechanical stiffness, M the mass and b the damping coefficient. The closed open pipe is filled with a fluid having mass density ρ_0, sound speed c,cross sectional area A , length L.

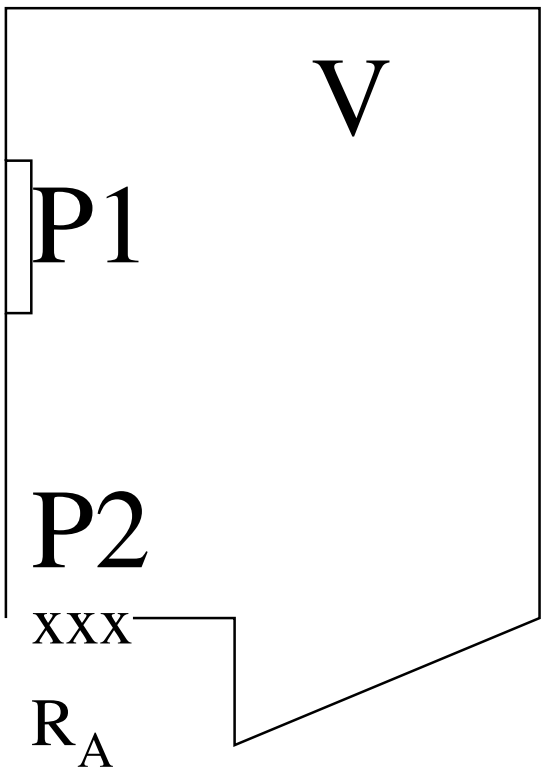


a. Using mobility analogy where the velocity as the "across" variable, determine the an equivalent circuit for the system.

b. Determine the equations of motion in the Laplace-domain.

c. Determine the equations of motion in the time-domain.

d. Find the transfer function $U_2(s)/U_o(s)$.



2. Consider the leaky headphone acoustical system where a rigid piston generates the pressure P_1. The interior of the headphone has a volume V. The acoustic resistance, denoted by XXX in the figure, is given $P/Q = R_A$ where P is the pressure and Q is the volume velocity..

a. Using impedance analogy where the pressure is the "across" variable and the volume velocity is the "through" variable determine the equivalent circuit of the system.

b. Determine the transfer function P_2/P_1.

c. Using your result what is the transfer function no-leak case i.e. $R_A = \infty$.

d. Using a Bode plot show the frequency response of the transfer function. What effect does R_A play in the result. Does your result agree with experimental observations.

3. Given the equations

$$x_1 = -x_1 - x_2 + u$$
$$x_2 = +x_1 - 2x_2$$

a. Draw the signal flow graph representation of the equations

b. Using Mason's gain formula Determine the transfer functions x_1/u and x_2/u.