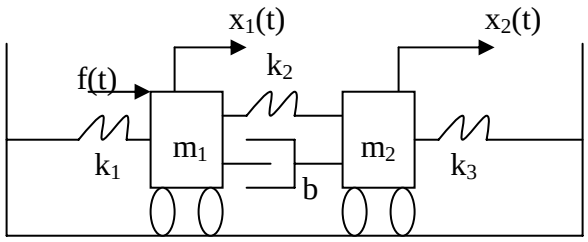
ENME462
Studio 2
System Modeling

This studio is intended to help solidify your modeling skills for mechanical and electrical systems. Each problem is to be done independently. Your studio TA will be available to assisst with any questions or difficulties in fundamentals of system modeling and MatLab use which may arise.

1. Consider the following 2-DOF translational mechanical system with zero initial conditions:

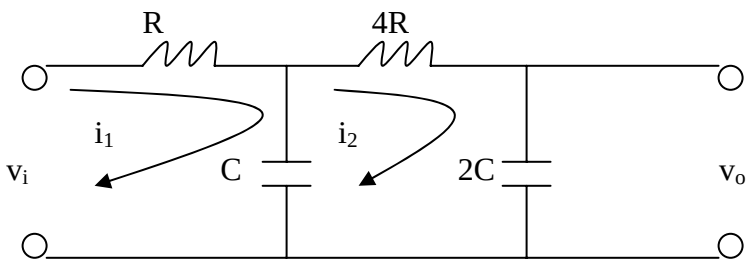


(a) Draw the free-body diagrams for m_1 and m_2
(b) Derive the 2 coupled differential equations of motion
(c) Convert the diff-eqns to the Laplace domain
(d) Find the transfer function $X_2(s)/F(s)$ (simplify to a ratio of 2 polynomials)
(e) Given $m_1=m_2=1$kg, b=1 Ns/m, $k_1=k_2=k_3=1$ N/m,
use MatLab to find the poles of $X_2(s)/F(s)$.

<u>Given f(t) = u(t) (step input):</u>
(f) Based on the pole values, qualitatively describe the expected nature of $x_2(t)$
(g) Use MatLab to plot $x_2(t)$.

<u>Poles:</u>
(h) Directly from the schematic of the system, how many poles would you expect the transfer function to have?
(i) If $m_1 = m_2 = 0$, how many poles would there be?

2. Consider the following electrical circuit:



(a) Redraw the circuit using equivalent impedance elements
(b) Find the transfer function $V_o(s)/V_i(s)$ by loop analysis
(c) Given R = 1 Ω, C = 0.1 F, and $v_i(t) = 10V\ u(t)$, solve for $V_o(t)$ by hand (you may use MatLab as a calculator to help find roots and solve for residues)
(d) Use MatLab to plot $v_o(t)$.