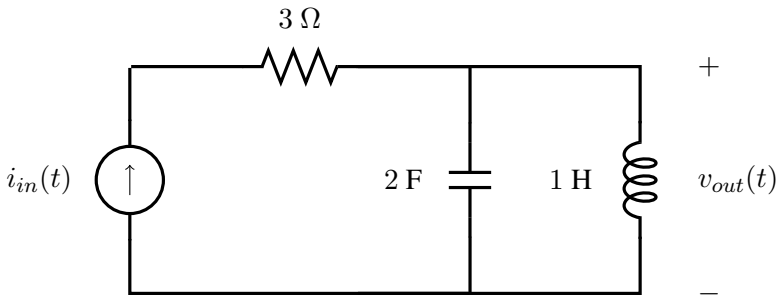
EENG307: Intro to Feedback Control

Fall 2020

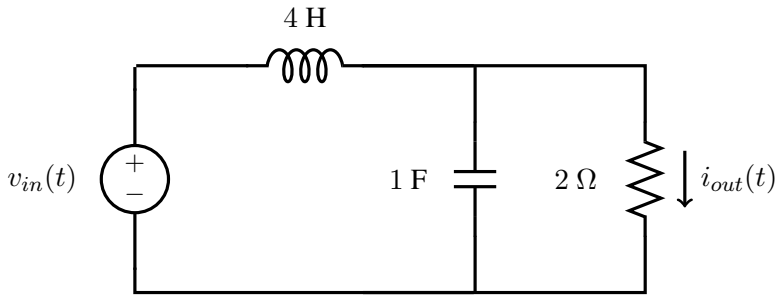
Homework Assignment #3

Due: 11:59pm, Wednesday Sept 16, 2020.

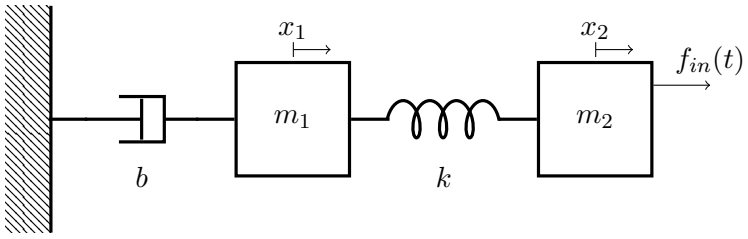
1. Find the transfer function from input i_{in} to output v_{out} for the following circuit



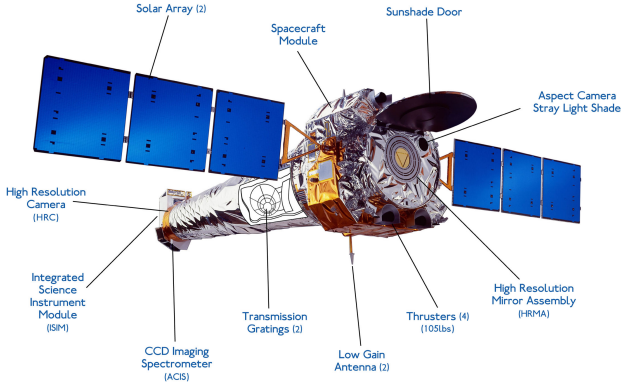
2. Find the transfer function for the following circuit with input v_{in} and output i_{out}.



3. Find the transfer function if the input is f_{in} and the output is x_1

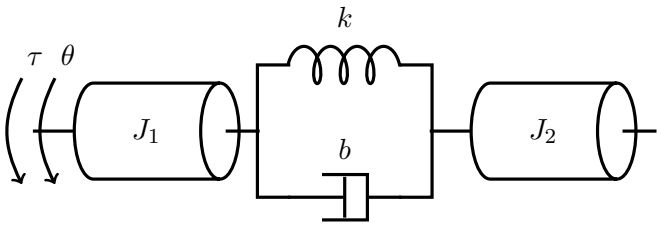


4. The Chandra X-ray Observatory is a space observatory sensitive to x-ray sources. To make observations the observatory must be precisely oriented.



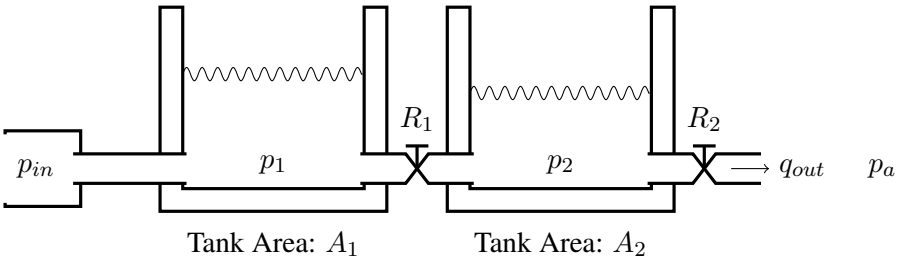
source:NASA

The observatory has a main body connected to solar panels on a lightweight frame. An ideal element model for motion of the the observatory around its major axis is shown in the following figure, where τ is the rotational torque applied by thrusters or reaction wheels, θ is the orientation of the main body, J_1 is the rotational inertia of the main body, and J_2 is the rotational inertia of the solar array, which has a flexible connection to the main body consistent with a damping ratio of b and a spring constant k.

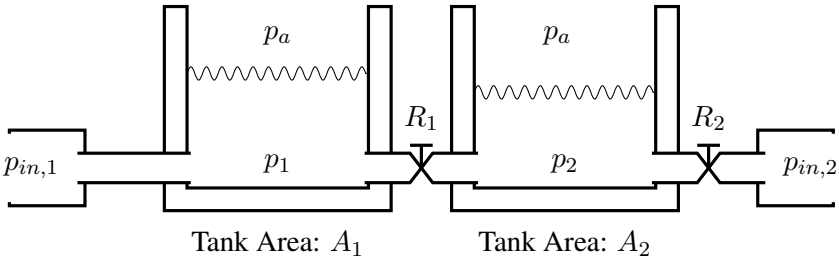


Find the transfer function from input τ, the applied torque, to output θ, the orientation of the satellite around is major axis.

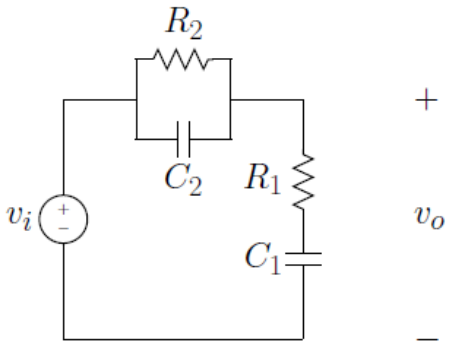
5. Find an equivalent circuit for the following fluid system. Liquid is supplied at the left at a pressure of p_{in}. The fluid density is ρ. Label p_1, p_2, p_a and q_{out} in this circuit.



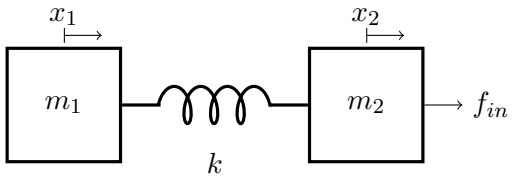
6. Find an equivalent circuit for the following fluid system. The pressure on the left and right, $p_{in,1}$ and $p_{in,2}$ are inputs. The fluid density is ρ. Label p_1, p_2, and p_a in the circuit, and use gauge pressure, so that all pressures are specified with respect to atmospheric pressure.



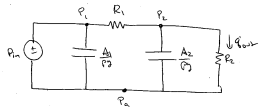
7. Quiz Question Monday: Find the transfer function from input v_i to output v_0 for the following circuit



8. Quiz Question Wednesday: Find the transfer function for the following mechanical system with force input f_{in} and output x_2.



Solutions:

1. $\frac{V_{out}(s)}{I_{in}(s)} = \frac{s}{2s^2+1}$
2. $\frac{I_{out}(s)}{V_{in}(s)} = \frac{1}{8s^2+4s+2}$
3. $\frac{X_1(s)}{F_{in}(s)} = \frac{k}{m_1m_2s^4+m_2bs^3+k(m_1+m_2)s^2+kbs}$
4. $\frac{\theta(s)}{\tau(s)} = \frac{J_2s^2+bs+k}{J_1J_2s^4+(J_1+J_2)bs^3+(J_1+J_2)ks^2}$
5. 
6.