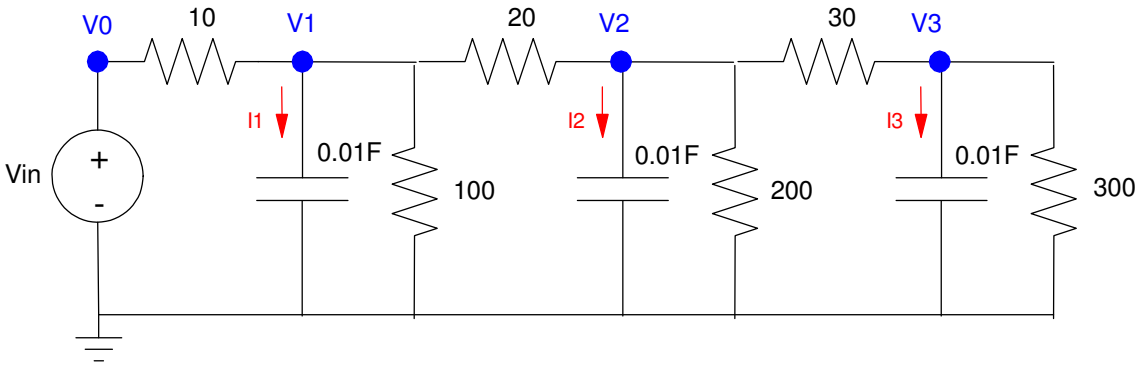
Homework #6: ECE 461/661

Electric Circuits, Mass-Spring Systems, Rotational Systems. Due Monday, September 29th

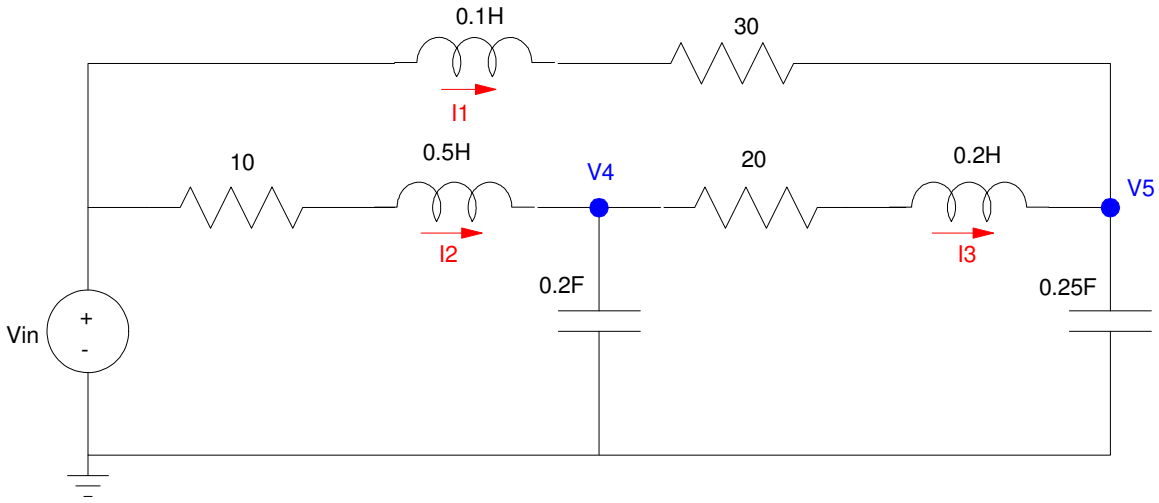
Electrical Ciruits

1) Express the dynamics of the following circuit in state-space form
   - Find the transfer function from Vin to V3



2) Express the dynamics of the following circuit in state-space form
   - Find the transfer function from Vin to V3

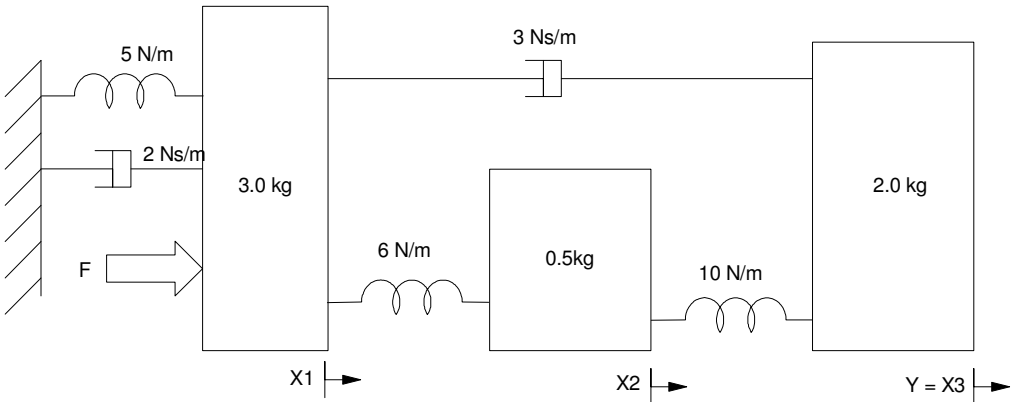
3) Assime Vin = 0. Specify the initial conditions so that the total energy at t = 0 is 1.0 Joules and
   - The transients decay as slow as possible
   - The transients decay as fast as possible



Mass Spring systems

4) Draw the circuit equivalent for the following mass-spring systems.

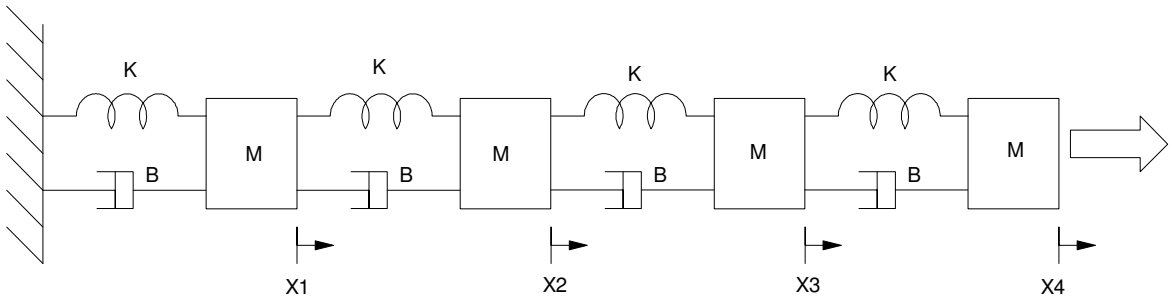
- Express the dynamics in state-space form
- Find the transfer function from F to X2
- Plot the step response from F to X2



Problem 4

5) Draw the circuit equivalent for the following mass-spring systems.

- Express the dynamics in state-space form
- Find the transfer function from F to X4
- Plot the step response from F to X4

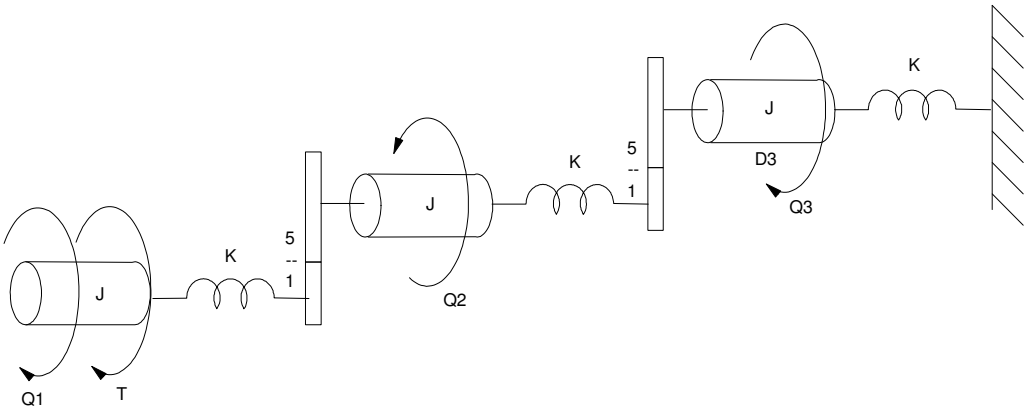


Problem 5: M = 2.0kg, B = 0.3 Ns/m, K = 10 N/m

Rotational Systems

6) Draw the circuit equivalent for the following rotational system.

- Express the dynamics in state-space form
- Find the transfer function from T to Q1
- Plot the step response from T to Q1



Problem 6: J = 2.5 Kg m / s^2. K = 20 Nm/rad, D3 = 1.5 Nms/ rad

Motors

7) Find the transfer function for the following DC servo motor

http://www.baldor.com/catalog/CDP3306

Allen Bradley CDP3306: 1/4 HP Servo Motor

- $716ea
- Kt = 1.117 ft-lb @ 1.68A
- Ra = 8.54 Ohms
- La = 60.59mH
- J = 4.680 lb-ft2
- 1.43A @ 1690rpm @ 0.945 ft-lb load
- 0.1A @ 180V @ 1830rpm @ 0 ft-lb load
- Weight 23.0kg

8) Assume this motor is used to power an electric bicycle at 20mph

- Motor speed @ 20mph = 1750 rpm
- Gear (wheel) used to convert 1750 rpm to 20mph
- Bicycle weight = 100kg

What is the gear reduction (wheel diameter) to convert 1750rpm to 20mph?

What is the inertia relative to the DC servo motor (bring the 100kg mass back to the motor through a gear)

What is the transfer function (dynamics) for the bicycle / servo motor combination?