**ENGINEERING ANALYSIS 3**

**SYSTEM DYNAMICS**

**SPRING 2019**

**HW #9**

Assigned June 5, 2019. This HW9 is optional but if you want to submit it, the deadline is June 5, 2019 (Wednesday) at 6:00 pm CST on Canvas.

Name : ____________________________ Section Number: ______

Please refer to the homework guidelines on the web regarding late HW policy and TA help.

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1. **(30 points)**

Consider the three electrical circuits below. An alternating input voltage, \( V = 5 \sin 2\pi t \) (Volts) is applied to each circuit as shown in the schematics.

A. For each electrical circuit, sketch the equivalent mechanical system.

B. For each equivalent mechanical system, plot the velocity of the spring, damper, or mass as a function of time over one cycle of behavior. Be sure to label the maximum and minimum velocities on your plot. (Hint: for the mass, there should be no connection to a fixed wall.)
2. **(30 points)**

Consider the following electrical system. SW1 is initially closed such that the system reaches steady state; once at steady state, the switch SW1 is then opened.

A. For the electrical circuit, derive the state equations for the system after SW1 is opened.

B. For the electrical system, combine the first order differential equations to form a second order differential equation in terms of the charge of the capacitor.

C. Sketch the equivalent mechanical system for electrical system for the case when SW1 is opened AFTER steady state is reached. Derive the state equations for the mechanical system for this case.

D. Compare the characteristic equations for your mechanical and your electrical systems. Find the roots of each characteristic equation. Comment on your results.
3. **(40 points)**

For the following electrical circuit,

a. Derive the two first order state equations.

b. Form a second order differential equation in terms of the charge of the capacitor.

c. Find the roots of the characteristic equation in terms of the parameters of electrical system. (Note: to find the roots of the characteristic equation you are looking for the homogeneous solution to the characteristic equation.)

d. Assuming that the values of C and R are known, derive an expression for L such that the system demonstrate oscillatory behavior.

e. Sketch the equivalent mechanical system for this electrical system.

f. Repeat Parts A-D for your mechanical system.

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That's it for HWs! Have a great summer!