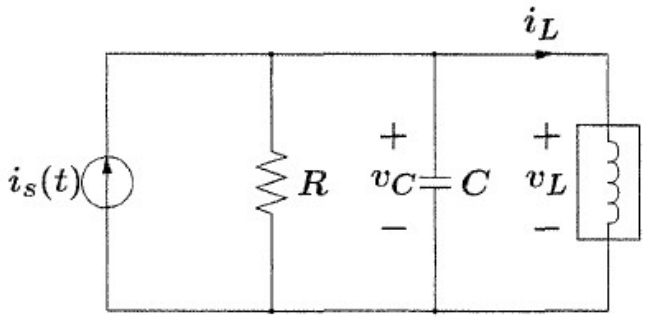
EEC 643/743/ESC794: Homework 1

Due on Jan. 28, 2019

Please include all the equation development, Matlab codes, Simulink model, and simulation results in your homework. Please have a cover page with "Homework 1" title and your printed name. The problems should be in order and all the pages should be stapled together. Any deviation from the required format will result in a deduction from the homework grade. The homework has to be completed independently and individually. Identical submissions will result in grades of ZERO.

1. The circuit shown in the figure below contains a nonlinear inductor and is driven by a time-dependent current source. Suppose that the nonlinear inductor is described by $i_L=I_0 sin(k\phi_L)$, where ϕ_L is the magnet flux of the inductor and I_0 and k are constants. Using ϕ_L and v_C as state variables, find the state equations.



2. Use Matlab/Simulink to simulate the stable electronic oscillator in Example 8 in Lecture 1. Choose two sets of initial conditions that are different from the ones on pages 28-30 in this lecture, and produce the phase plane (or XY plane) plots and plot output responses with the various initial conditions. In your simulation, please choose A=1.5, V_1=V_2=1, L=1H, C=1F, and R=0.1Ω.

3. For the following system, find the equilibrium points and determine the type of each isolated equilibrium point.

$$\begin{cases} \dot{x}_1 = 2x_1 - x_1x_2 \\ \dot{x}_2 = 2x_1^2 - x_2 \end{cases}$$

4. By plotting trajectories starting at different initial conditions, draw the phase portrait of the following LTI systems:

$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = -10x_1 - 10x_2 \end{cases}$$

Hint: Use Matlab command “initial”, and the hold function when plotting.

5. The phase portrait (or phase-plane plot) of the following system is shown below. Mark the arrowheads and discuss the stability of each isolated equilibrium point.

$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = x_1 - 2\tan^{-1}(x_1 + x_2) \end{cases}$$

Please note the equilibria of the system above are (0, 0), (2.33, 0), and (-2.33, 0).