Part II: Modeling problem
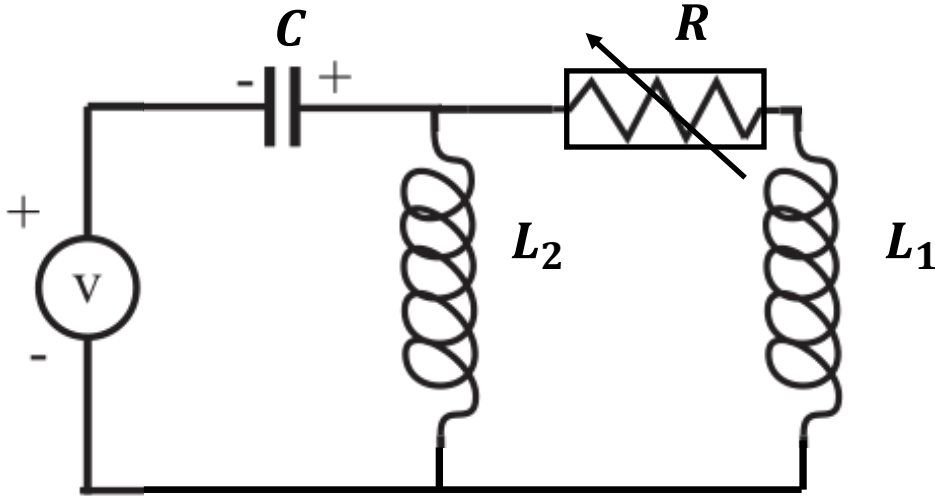
Instructions:
1. Use MATLAB to solve the problem if needed;
2. Please submit the published pdf file ONLY.
3. Please use `type function_name` in the end of your main script for displaying your nonlinear function. (i.e. all the functions that are written in separate files should be displayed with `type` command)

For the circuit with the nonlinear resistor satisfying the nonlinear dependence of the resistor's voltage V_R as a function of its current I where:

$$V_R = RI - RI^3, R = 1\Omega, C = 1F, L_1 = L_2 = 1H$$

a) Write a state space model $\dot{x} = f(x, V)$ using Kirchoff equations. Choose the inductors currents and the capacitor's voltage as state variables (i.e. $x_1 = i_{L1}, x_2 = i_{L2}, x_3 = v_c$) and choose the current over L_1 as the output (i.e. $y = x_1$).

b) Find ALL equilibrium points for the constant input voltage V^{eq};

c) Around which equilibrium points is the linearized model unstable and which is stable? Why? Check the eigenvalues for each equlibrium state.

d) Simulate and compare the linearized and the nonlinear system using MATLAB.

e) Demonstrate stability and instability around each equilibrium point of both the linear and nonlinear models for the same initial conditions and the same input.

f) Is your model valid? Use circuit analysis of both the linear and nonlinear system models to explain the steady state and transient behavior.