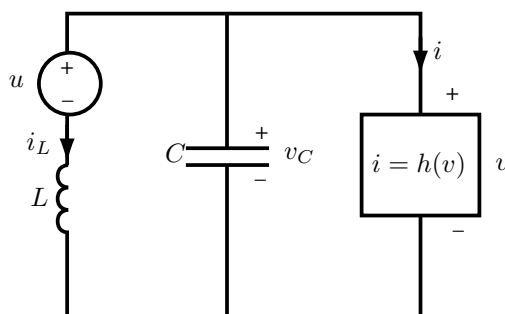# ECE311S: Dynamic Systems and Control
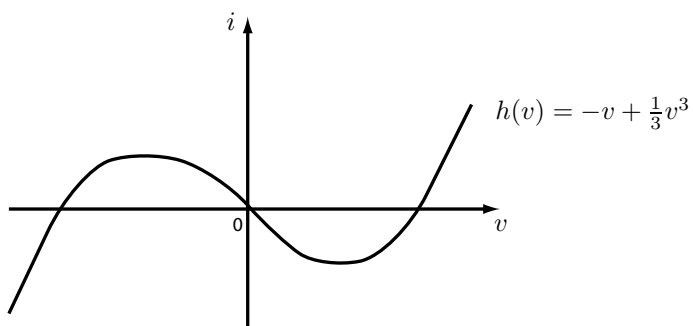
Problem Set 1

Problem 1

The controlled Van der Pol oscillator has the circuit diagram shown below.

The output of the system is the voltage accross the capacitor, v_C. The nonlinear element of the circuit has a characteristic $i = h(v)$, depicted below, with $h(v) = -v + \frac{1}{3}v^3$.

(i) Write the mathematical model of the system in terms of v_C, i_L, and u.

(ii) Letting $x_1 = i_L$ and $x_2 = v_C$, write the state-space model of the system.
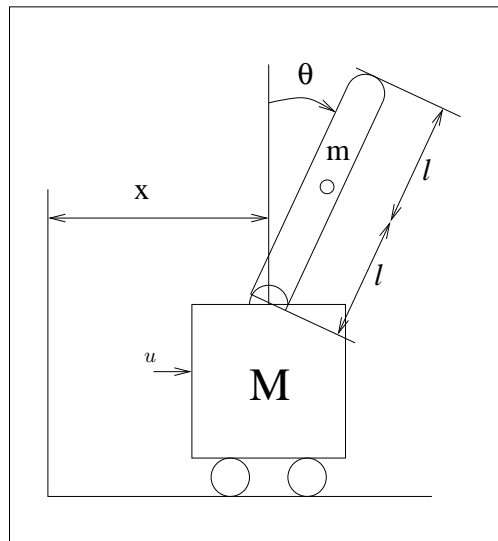
Problem 2

Write the equations of motion of the system below, where x_1 and x_2 represent deviations from the equilibrium position.
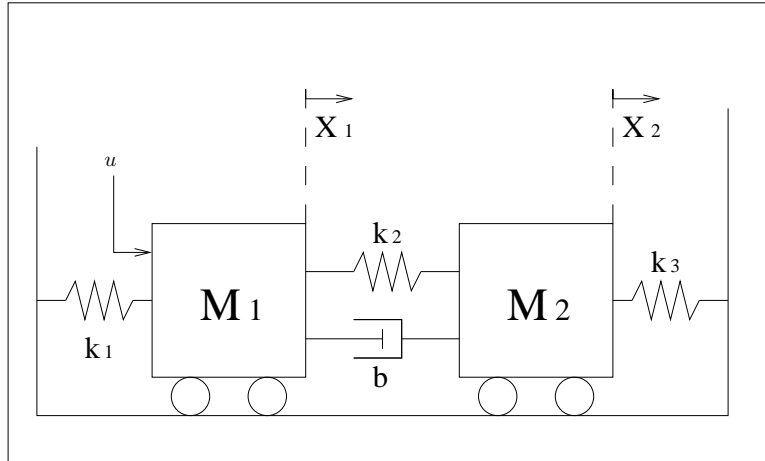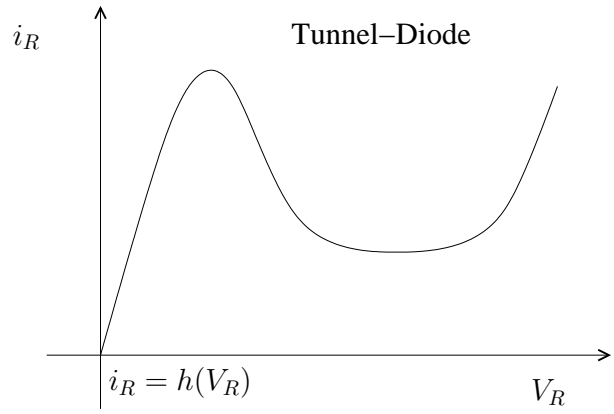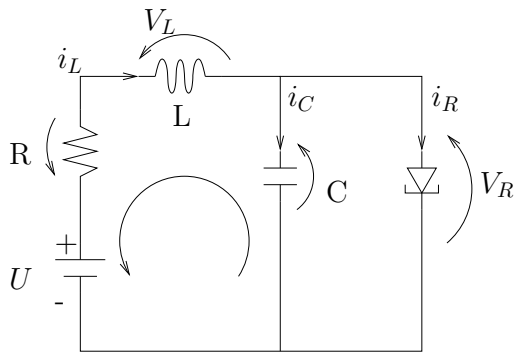
Problem 3

Write the equations of motion of the system below.

- Suppose the center of gravity of the pendulum rod is at its geometric center.

- Neglect the moment of inertia of the wheels.

Problem 4

1. Write the equations of the circuit below.

2. Write the state-variable model of the system.

3. Find the equilibria holding u constant.

i_L

V_L

L

i_C

i_R

R

C

V_R

U

$+$

$-$

i_R

Tunnel–Diode

$i_R = h(V_R)$

V_R

The diode has a nonlinear characteristic