CENG 215 CIRCUITS and ELECTRONICS

Project #1 - A

Task: Write a Python code to simulate the circuit shown below. The circuit contains a special nonlinear diode (called *X-diode*), an inductor, and one capacitor. Node voltages are denoted by $V_c(t)$ and $V_l(t)$ as in the original schematic.

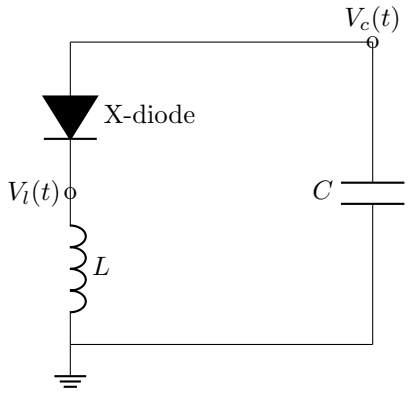

Figure 1: Two-branch circuit: left branch X-diode and inductor in series, right branch capacitor.

X-diode model:
In this project you *must not* use the standard Shockley diode equation. Instead, the diode current--voltage characteristic of the X-diode is given *only* by the measured curve in Fig. 2. This curve is specific to this exam and does not correspond to any standard datasheet model.

According to this V-I characteristics, for example, $v_D \cong 0.25V$ when $0 < i_D < 5mA$, $v_D \cong 0.6V$ when $15 < i_D < 17.5mA$, and so on. Also note that diode does not allow negative currents, meaning that it becomes open circuit when current drops to zero.

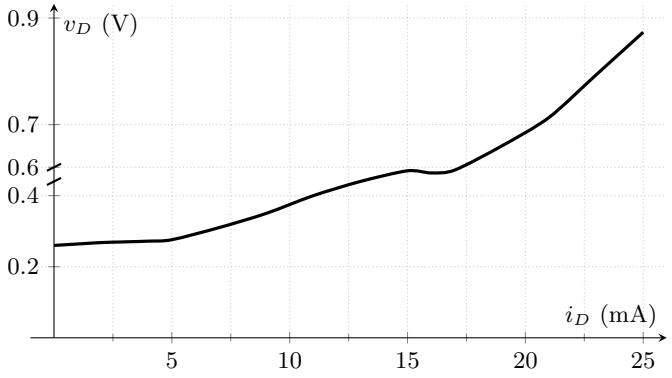

Figure 2: Approximate measured i_D–v_D characteristic of the X-diode.

Important: The vertical axis in Fig. 2 uses a non-uniform scale. The tick labels (0, 0.2, 0.4, 0.6, 0.7, 0.9 V) do not correspond to equal spacing in the plot. You must read the curve qualitatively and construct a suitable approximate model (e.g., piecewise linear model) for your simulation.

Simulation tasks:

Write a Python program that:

a) Approximates the X-diode i_D--v_D characteristic in Fig. 2 by a suitable analytical or piecewise defined function that you can use in a time-domain circuit simulation (e.g., in a function v_diode(i) or i_diode(v)). State clearly in your report how you obtained this approximation from the graph.

b) Simulates the transient behavior of the given circuit assuming that the initial voltage of the capacitor is given as $V_c(0) = 3$ volts. Inductor has no initial energy ($i_l(0) = 0$)

(Use state equations and Euler method for simulation)

c) Plots $V_c(t)$ and $V_l(t)$ on appropriately scaled axes.

d) Find out the final value of the capacitor voltage V_c.

What to submit:

At the end of the lab session, submit a brief report (as a Word or PDF document) that includes:

1. Your Python code.
2. Your approximate mathematical model of the X-diode characteristic (derived from Fig. 2).
3. Simulation results: clearly labeled plots of $V_c(t)$ and $V_l(t)$ for both input signals.