

# CENG 215 CIRCUITS and ELECTRONICS

## Project #1 - B

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  $V_a(t)$  and  $V_b(t)$  as in the original schematic.

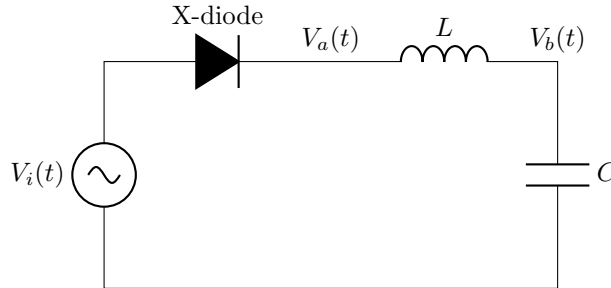


Figure 1: Series X-diode-L-C circuit with node voltages  $V_a(t)$  and  $V_b(t)$ .

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,  $v_D \approx 0.25V$  when  $0 < i_D < 5mA$ ,  $v_D \approx 0.6V$  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.

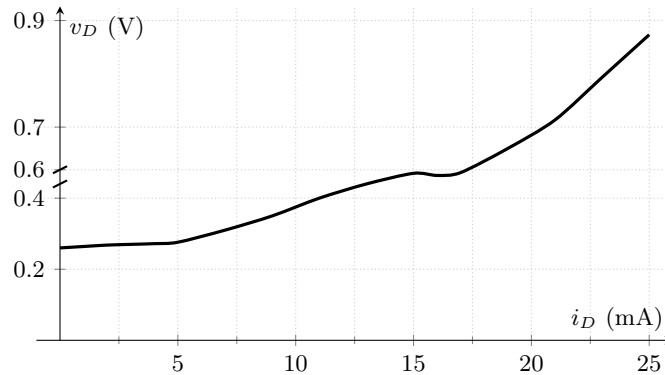


Figure 2: Approximate measured  $i_D$ - $v_D$  characteristic of the X-diode.

**Important:** The vertical axis in Fig. 2 uses a non-uniform scale. The tick labels (0, 0.2, 0.4, 0.6, 0.7, 0.9V) 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 for the following input voltage:  
 $V_i(t) = 0.8$  volts,  
Use state equations and Euler method for simulation.
- c) Plots  $V_a(t)$  and  $V_b(t)$  on appropriately scaled axes.
- d) Find out the final value of the capacitor voltage  $V_b$ .

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  $V_a(t)$  and  $V_b(t)$  for both input signals.