CENG 215 CIRCUITS and ELECTRONICS

Project #1 - Preparation Question

Task: Write a Python code to simulate the circuit shown below. The circuit contains a special nonlinear diode (called *X-diode*), a resistor, and a capacitor. Node voltage is denoted by $V_o(t)$ as in the original schematic.

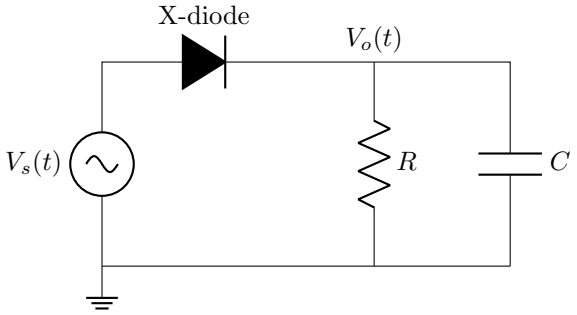

Figure 1: Series source $V_s(t)$, X-diode and parallel R–C load with output $V_o(t)$ across R and C.

X-Diode is a special non-linear device that does not exist in reality. Its current - voltage characteristic is given in Fig. 2. This curve is specific to this exam and does not correspond to any standard datasheet model.

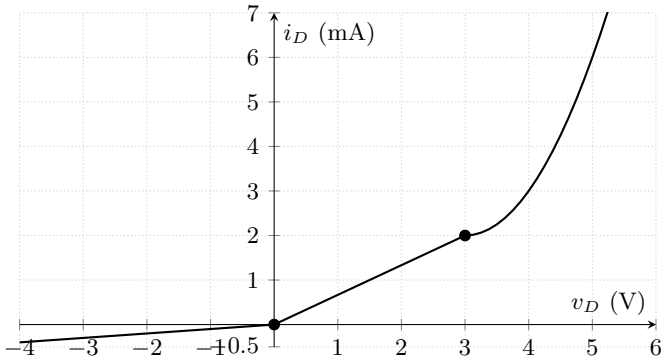

Figure 2: Piecewise i_D - v_D characteristic of the X-diode: $i_D = 0.1V$ for $v_D < 0$, $i_D = \frac{2}{3}v_D$ for $0 \leq v_D \leq 3$, and $i_D = (v_D - 3)^2 + 2 \;\; mA$ for $v_D > 3$.

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)).

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 and $V_s(t) = 10sin(10t)$, $C = 1\mu F$ and $R = 50k\Omega$. (Use state equations and Euler method for simulation)

c) Plots $V_s(t)$ and $V_o(t)$ on appropriately scaled axes.