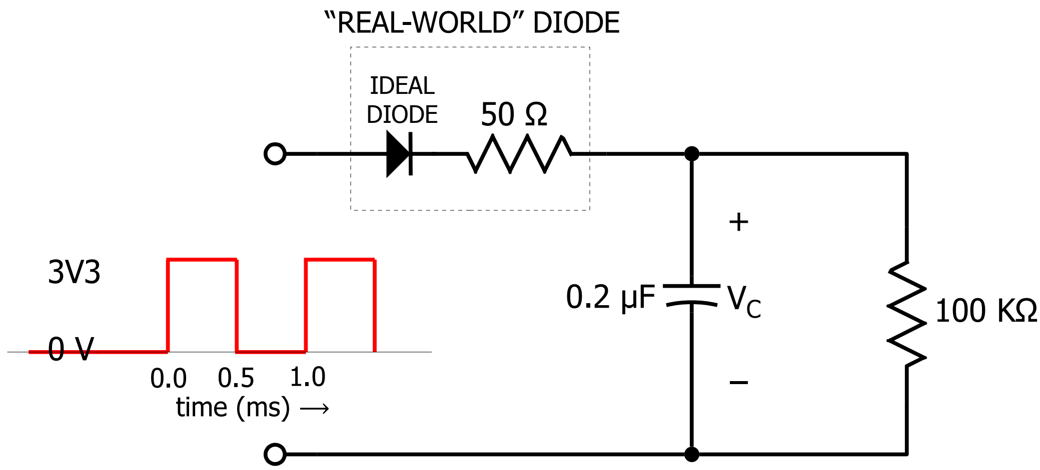
EE3 Fall 2020
Homework Problem 4



The input voltage has been at 0 V for a long time. All transients have died out. At time t = 0.0, a 3V3 pulse train begins. NOTE: the device inside the dashed-line box in an approximation of a real-world diode: when the left end is positive with respect to the right end, it is **forward-biased** and its resistance is 50 Ω. When the left end is negative, it is **reverse-biased** and its resistance is ∞.

a. When the input voltage is 3V3, the diode is forward-biased; 3V3 > v_C. What is the charging time constant? Neglect the effect of the 100 KΩ resistor.

b. When the input voltage is 0 V, the diode is reverse-biased, v_C > 0 V, and the capacitor can discharge only through the 100 KΩ resistor. What is the discharging time constant?

c. What is v_C at time 0.0^+?

d. What is v_C at time 0.5^+? You will need to evaluate the equation describing the behavior a shown on Slide 3 of Lecture 4 on CCLE Week 3.

e. What is v_C at time 1.0^+? Remember that v_C cannot change in the transition from 0^- to 0^+.

f. Based on what you see in (d.) and (e.), predict the value of v_C at time 1.5^+.

a. $\tau_{chg} = (50)\cdot(0.2\text{e-}6) = 10\ \mu\text{s}$

b. $\tau_{dischg} = (100\text{e}3)\cdot(0.2\text{e-}6) = 20\ \text{ms}$

c. $v_c(0^+) = v_c(0^-) = 0\ \text{V}$

d. $v_c(0.5\text{e-}3^+) = v_c(0.5\text{e-}3^-) = 3.3 \cdot \left(1 - e^{\frac{-0.5\text{e-}3}{50\cdot 0.2\text{e-}6}}\right) \approx 3.3\cdot(1-0) = 3.3\ \text{V}$

e. $v_c(1.0\text{e-}3^+) = v_c(1.0\text{e-}3^-) = 3.3 \cdot e^{-\frac{0.5\text{e-}3}{100\text{e}3\cdot 0.2\text{e-}6}} = 3.3\cdot e^{-0.025} = 3.22\ \text{V}$

f. Prediction: $v_c = 3.3\ \text{V}$