

Due: 23:55, April 8 (Wednesday night)

We have 8 problems.

In your answer file, specify both the **SOLUTION PROCEDURE** and the **FINAL SOLUTION**.

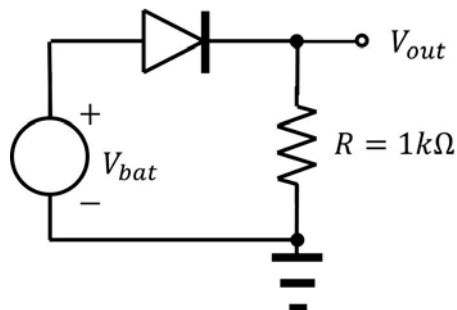
1. For a diode, the terminal current and the terminal voltage are related by $I = I_S \left(\exp\left(\frac{V}{V_T}\right) - 1 \right)$.

Express $\frac{dI}{dV}$ using only $(I + I_S)$ and V_T .

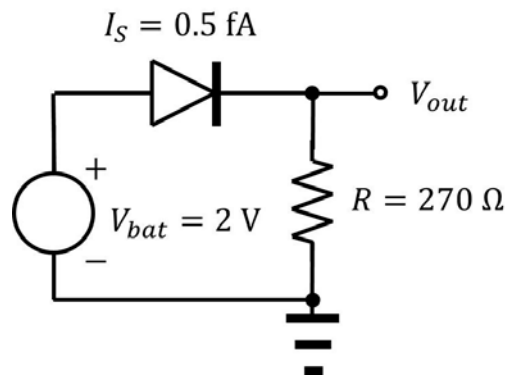
2. The reverse saturation current of a pn junction is 10^{-15} A. We want to have 1 mA in the forward mode. What is the required forward bias voltage?

3. Consider two diodes. For a diode, $I = I_S \left(\exp\left(\frac{V}{V_T}\right) - 1 \right)$. For the other one, due to many defects inside the diode, $I = I_S \left(\exp\left(\frac{V}{2V_T}\right) - 1 \right)$. In this problem, the reverse saturation currents of two diodes are identical. When the applied anode voltage is 0.60 V, estimate the ratio between two diode currents. Assume the room temperature.

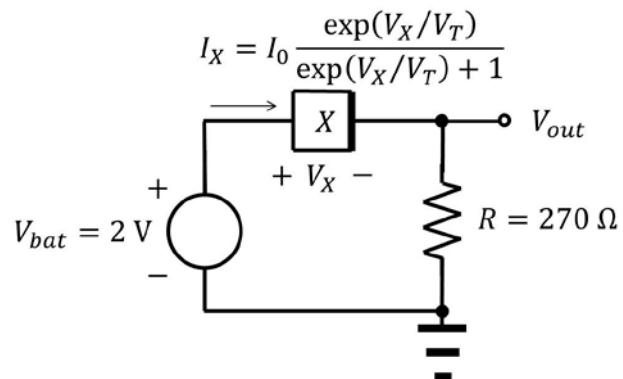
4. Assume the room temperature. Consider a diode, which conducts 30 pA, when the diode voltage is 0.3 V. By using such a diode, the following circuit is made. The output voltage is 0.3 V. Calculate the value of V_{bat} .



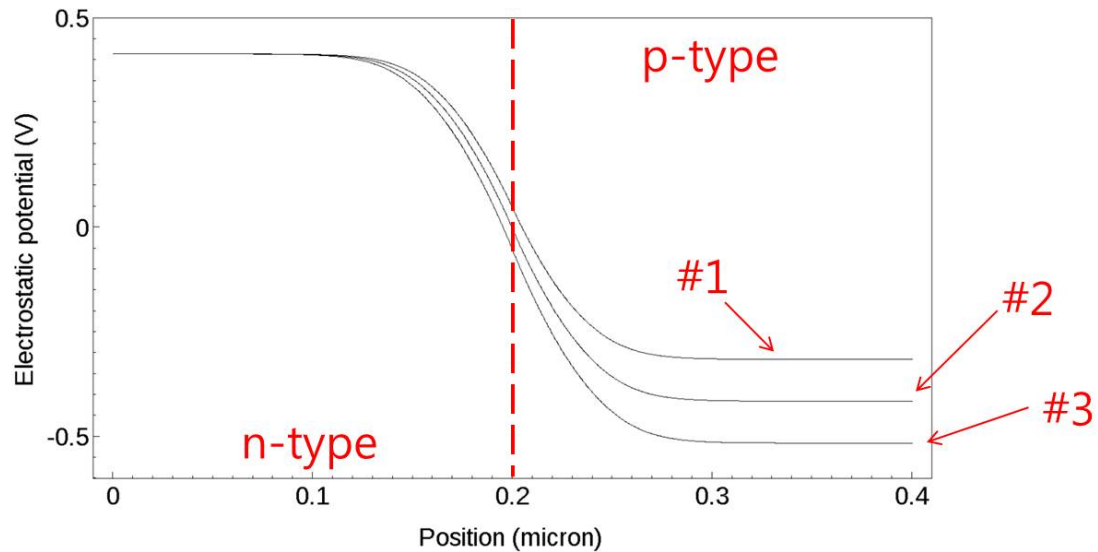
5. The reverse saturation current of the diode is 0.5 fA. Calculate the output voltage. Write your answer in the mV scale. DO NOT USE THE CONSTANT-VOLTAGE MODEL.



6. A new two-terminal element is introduced. (It is a fictitious one for this problem.) Its current-voltage relation is found to be $I = I_0 \frac{\exp(V/V_T)}{\exp(V/V_T) + 1}$. Of course, V_T is the thermal voltage. In this problem, I_0 is 1 mA. Calculate the output node voltage. Write your answer in the mV scale.



7. Three curves represent the electrostatic potential profiles for a pn diode. (Neglect the offset value of the electrostatic potential.) One of them is obtained at equilibrium. Another curve is for the forward mode (+0.1 V) and the other for the reverse mode (-0.1 V). Among the three curves, which one is the curve for the forward mode? Specify the correct curve index.



8. Three curves represent the diode currents as functions of the diode forward voltage. Although the diode is the same, the temperature is different for each curve. (250 K, 300 K, and 350 K) Among the three curves, which one is for 250 K? Specify the correct curve index.

