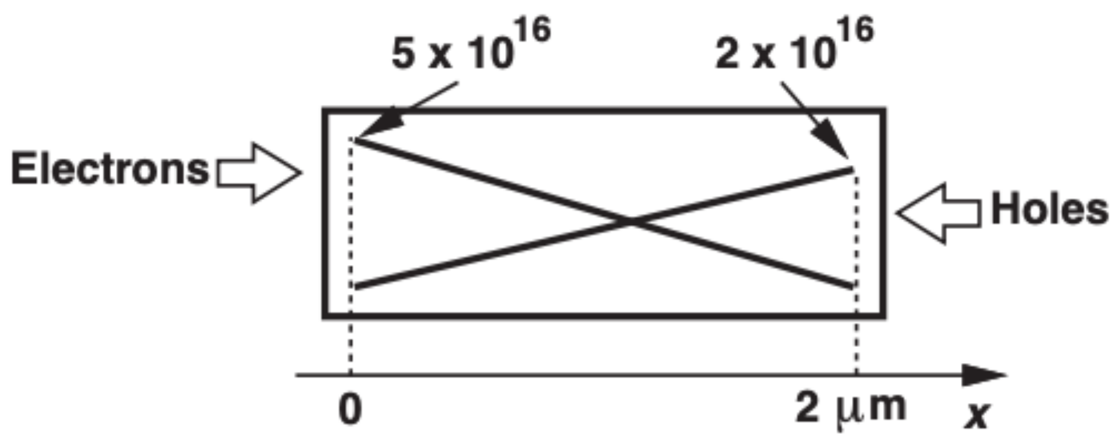
Problem 1

- Figure below shows a *p*-type bar of silicon that is subjected to electron injection from the left and hole injection from the right. Determine the total current flowing through the device if the cross section area is equal to 1 µm × 1 µm.

$D_n = 34cm^2/s \quad D_p = 12cm^2/s$



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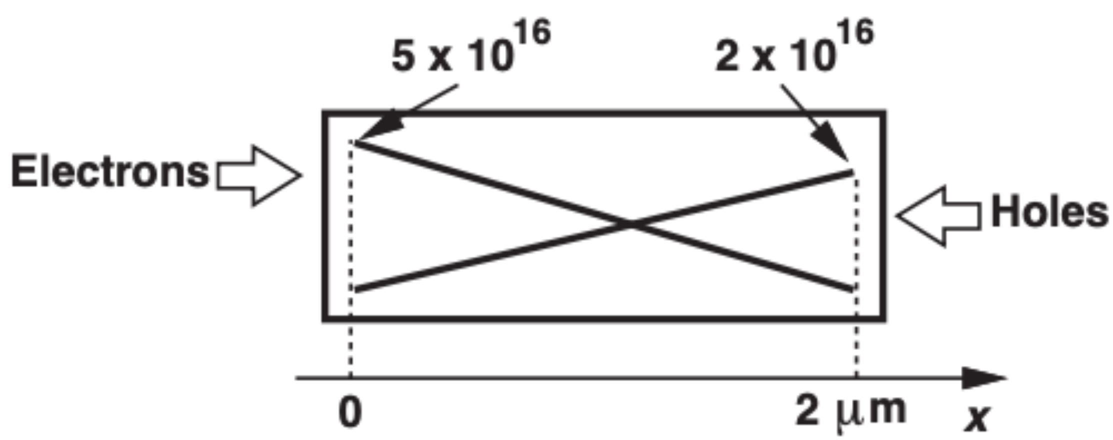
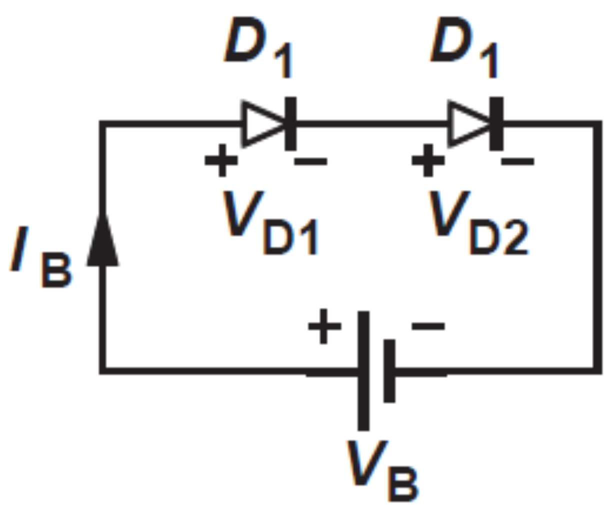
Problem 1: Solution

- given: L=2 µm, A=1 µm² $D_n = 34cm^2/s$ $D_p = 12cm^2/s$
- $I_{tot} = A\,.\,J_{tot}$
- $I_{tot} = A\,.\,q(D_n\dfrac{dn}{dx} - D_p\dfrac{dp}{dx})$
- $I_{tot} = (1\mu m^2) \times 10^{-8} \times 1.6 \times 10^{-19}(34(cm^2/s)\dfrac{-5 \times 10^{16}(cm^{-3})}{10^{-4} \times 2\mu m} - 12(cm^2/s)\dfrac{2 \times 10^{16}(cm^{-3})}{10^{-4} \times 2\mu m})$
- $I_{tot} = -1.552 \times 10^{-5}A \rightarrow -15.52\mu A$ to verify



Problem 2

- Figure below shows two diodes with reverse saturation currents of I_{S1} and I_{S2} placed in series. Calculate I_B, V_{D1}, and V_{D2} in terms of V_B, I_{S1}, and I_{S2}.



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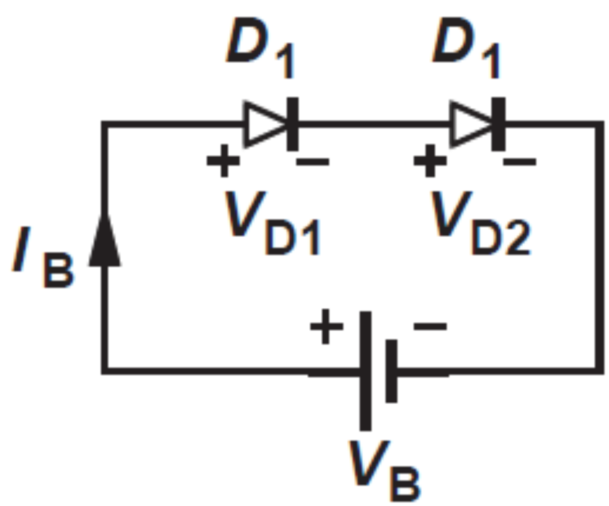
Problem 2: Solution

- $V_B = V_{D1} + V_{D2}$
- Knowing that $I_D \simeq I_s exp\dfrac{V_D}{V_T} \Rightarrow V_D = V_T ln(\dfrac{I_D}{I_s})$
- $V_B = V_{D1} + V_{D2} = V_T ln(\dfrac{I_B}{I_{s1}}) + V_T ln(\dfrac{I_B}{I_{s2}}) = V_T ln(\dfrac{I_B^2}{I_{s2} I_{s1}})$
- $\Rightarrow I_B = \sqrt{I_{s1} I_{s2} exp(\dfrac{V_B}{V_T})} = \sqrt{I_{s1} I_{s2}} exp(\dfrac{V_B}{2V_T})$



Problem 2: Solution

- $\Rightarrow I_B = \sqrt{I_{s1}I_{s2}exp(\frac{V_B}{V_T})} = \sqrt{I_{s1}I_{s2}}exp(\frac{V_B}{2V_T})$
- $\Rightarrow V_{D1} = V_T ln(\frac{I_B}{I_{s1}}) = V_T ln(\sqrt{\frac{I_{s2}}{I_{s1}}}) + \frac{V_B}{2}$
- $\Rightarrow V_{D2} = V_T ln(\frac{I_B}{I_{s2}}) = V_T ln(\sqrt{\frac{I_{s1}}{I_{s2}}}) + \frac{V_B}{2}$
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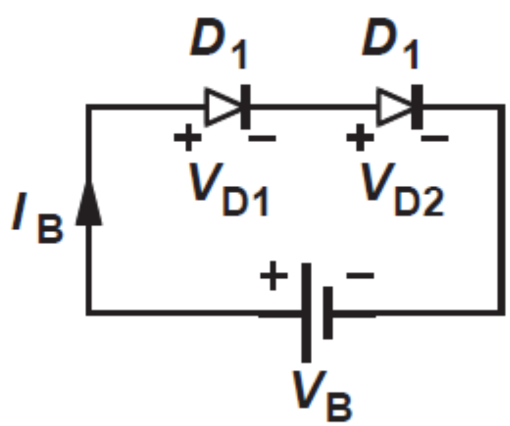
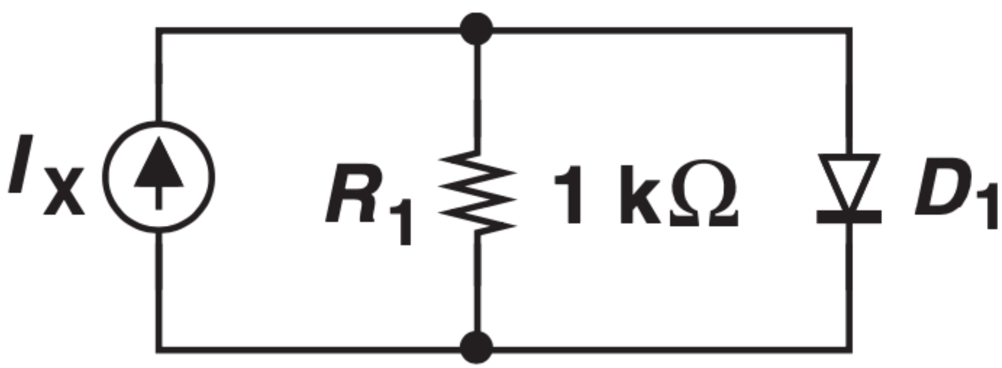


Problem 3

- In the circuit of Fig. below, we wish D_1 to carry a current of 0.5mA for I_X =1.3mA. Determine the required reverse saturation current I_S .



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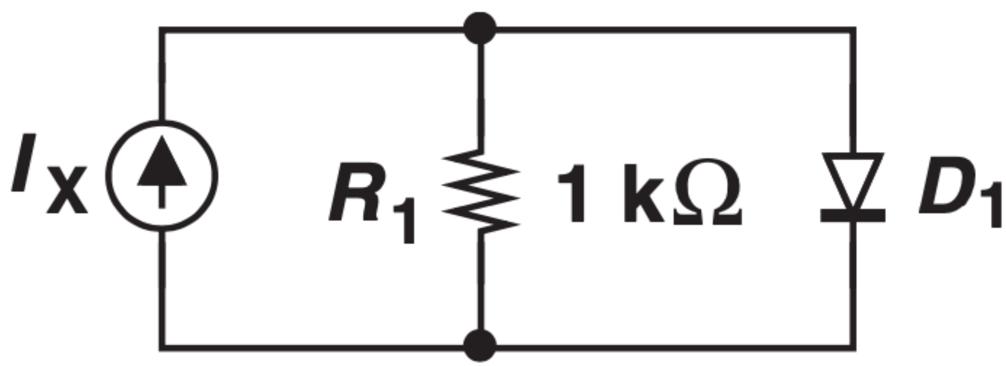
Problem 3: Solution

- $I_{D1} \simeq I_s exp\frac{V_{D1}}{V_T} \Rightarrow I_s \simeq I_{D1} exp\frac{-V_{D1}}{V_T}$
- $I_{D1} = 0.5mA, V_{D1}?$
- $V_{D1} = RI_R = R(I_x - I_{D1}) = 0.8V$
- $I_s \simeq I_{D1} exp\frac{-V_{D1}}{V_T} = 2.168 \times 10^{-17}A$



- $$I_s = Aqn_i^2(\frac{D_n}{N_A L_n} + \frac{D_p}{N_D L_p})$$