ECE 235: Introduction to Solid State Electronics

Discussion

Week 11

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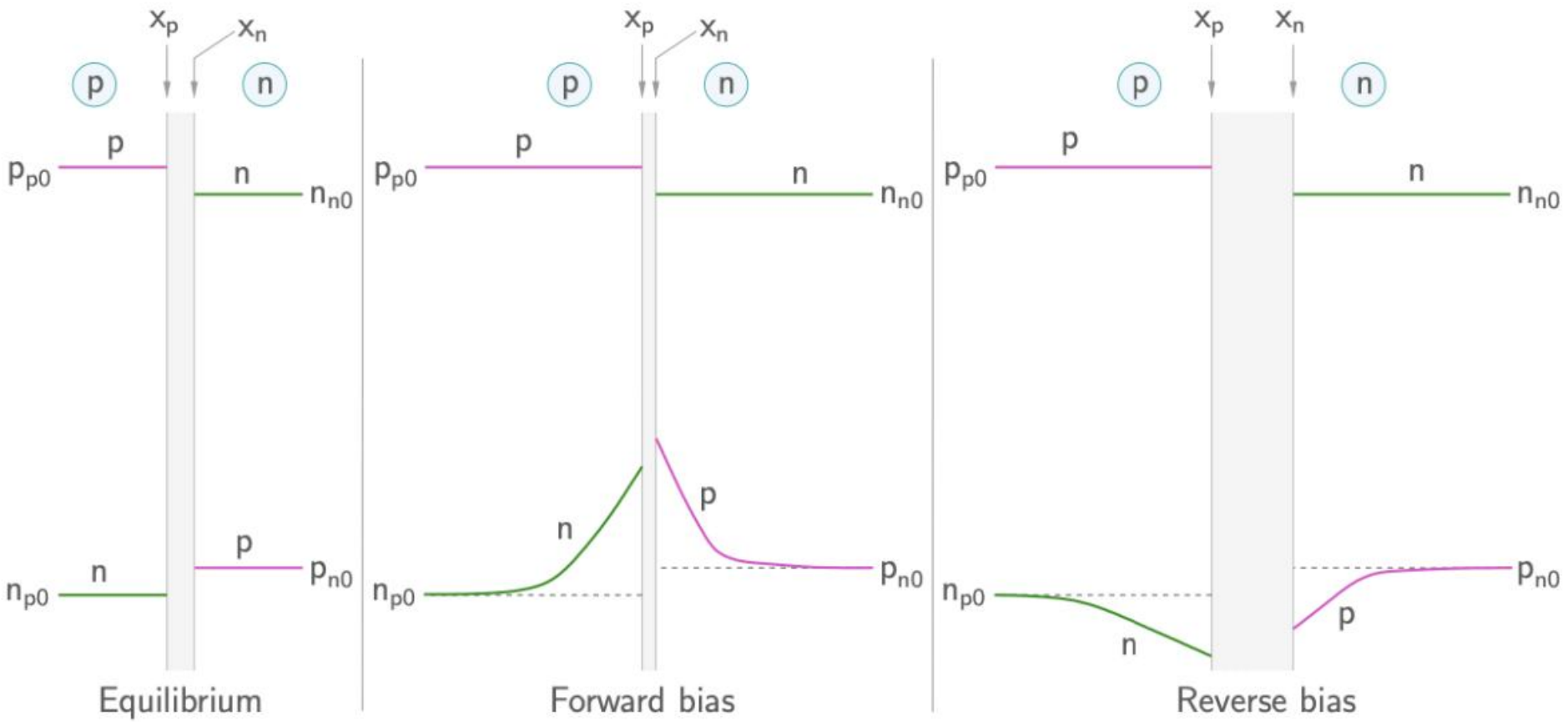
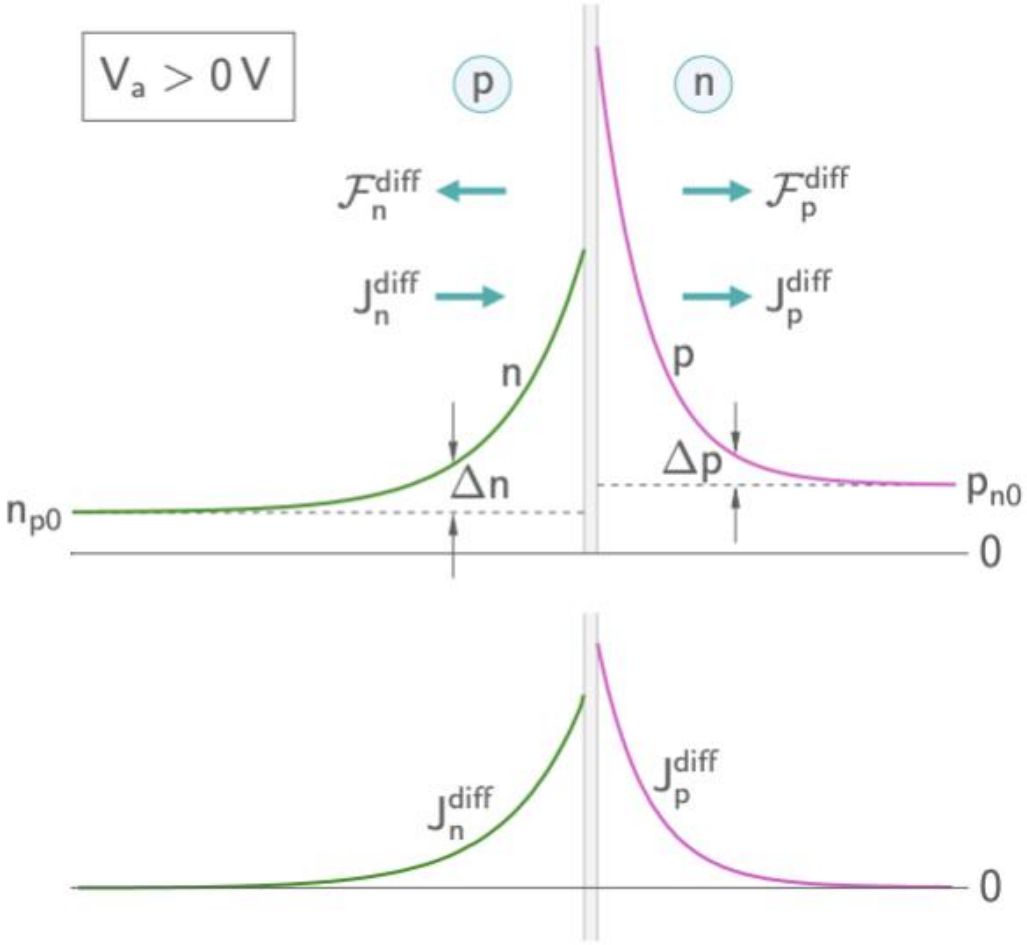
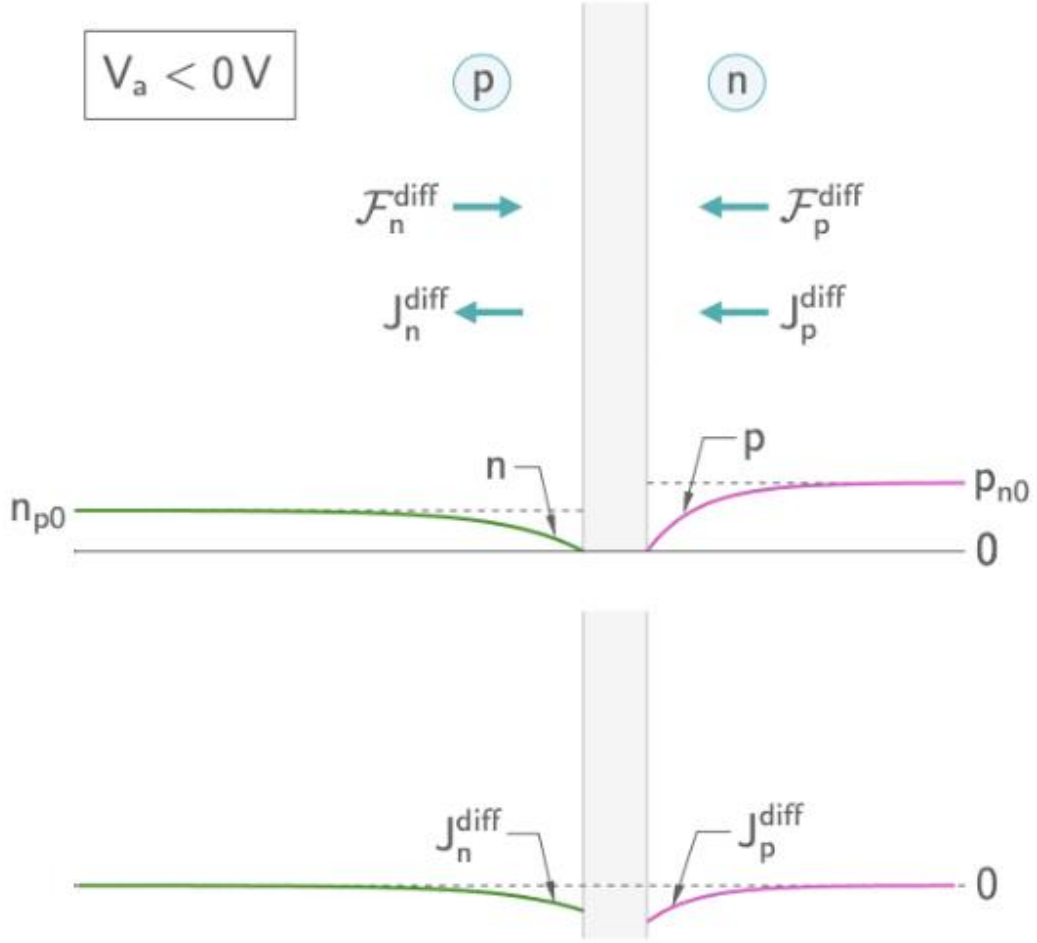
Charge Profile



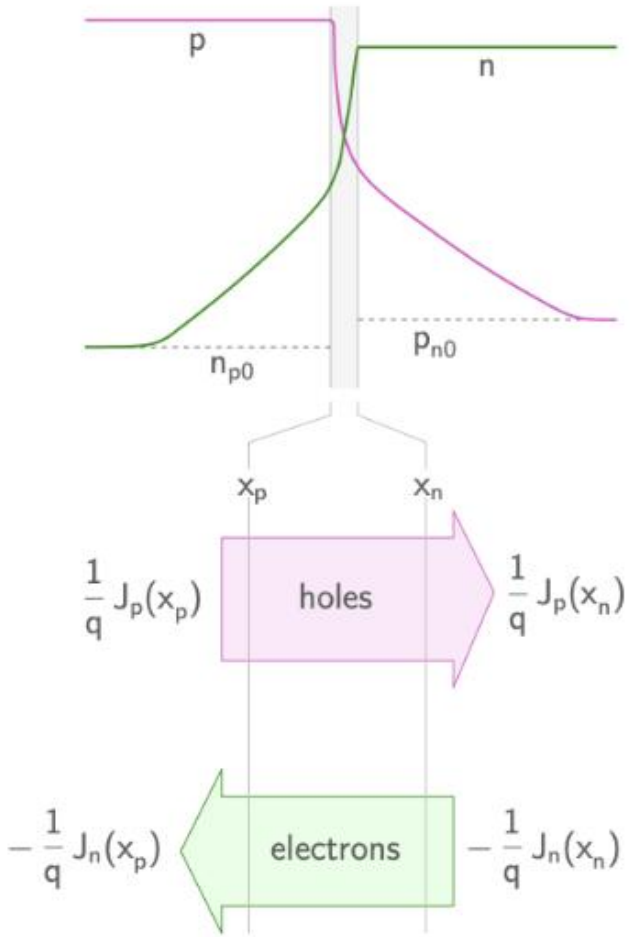
Forward Bias

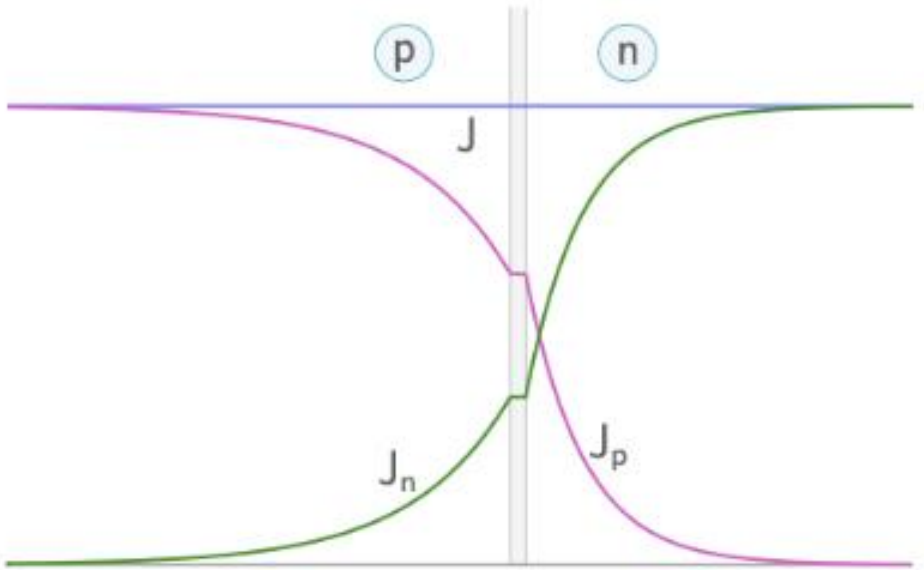


Reverse Bias



Total Current





Practice Problem 1

Consider a silicon pn junction at $T = 300$ K. Assume the doping concentration in the n region is $N_d = 10^{16}\ \text{cm}^{-3}$ and the doping concentration in the p region is $N_a = 6 \times 10^{15}\ \text{cm}^{-3}$, and assume that a forward bias of 0.60 V is applied to the pn junction.

Calculate the minority carrier concentrations at the edge of the space charge regions in a forward-biased pn junction. $n_i = 1.5 \times 10^{10}\ \text{cm}^{-3}$

Practice Problem 2

Determine the ideal reverse-saturation current density in a silicon pn junction at $T = 300$ K.

Consider the following parameters in a silicon pn junction:

$$N_a = N_d = 10^{16}\ \text{cm}^{-3} \qquad n_i = 1.5 \times 10^{10}\ \text{cm}^{-3}$$

$$D_n = 25\ \text{cm}^2/\text{s} \qquad \tau_{p0} = \tau_{n0} = 5 \times 10^{-7}\ \text{s}$$

$$D_p = 10\ \text{cm}^2/\text{s} \qquad \epsilon_r = 11.7$$

Practice Problem 3

Consider a silicon pn junction diode at $T = 300$ K. Design the diode such that $J_n = 20$ A/cm^2 and $J_p = 5$ A/cm^2 at $V_a = 0.65$ V. Assume the remaining semiconductor parameters are as

[redacted]

$n_i = 1.5 \times 10^{10}$ cm^{-3}

$D_n = 25$ cm^2/s

$\tau_{p0} = \tau_{n0} = 5 \times 10^{-7}$ s

$D_p = 10$ cm^2/s

$\epsilon_r = 11.7$

Practice Problem 4

For a pn junction diode assuming the total current is conducted by the electric field far from the junction, calculate the electric field. Assume the applied forward bias voltage is 0.65 V and temperature is 300 K. Other diode parameters are given in Practice Problem 2.