EE105 - Fall 2005
Microelectronic Devices and Circuits

Lecture 5

PN Junction
Diode

Announcements

- Homework 2, due today
- Homework 3, due next week
- Labs start this week
- I am away on Thursday; lecture by Sebastian Hoyos
- Reading: Chapter 3 (3.1-3.6), Chapter 6

Lecture Material

- Last lecture
  - IC capacitors
  - PN junction
- This lecture
  - PN junction in reverse and forward bias

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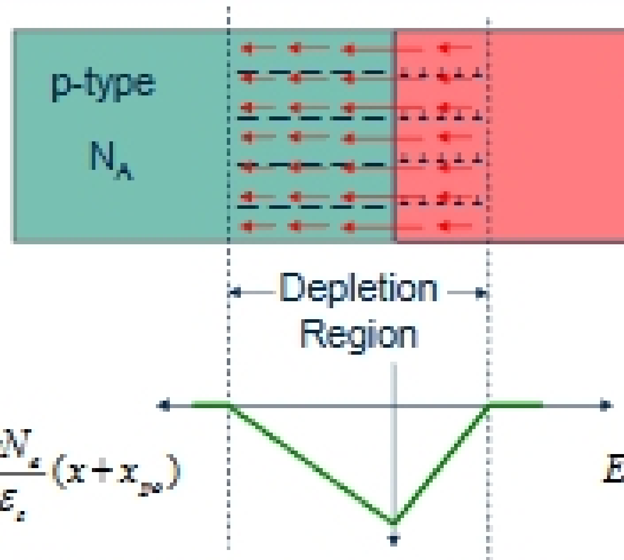
Plot of Fields In Depletion Region



$$E_0(x) = -\frac{qN_a}{\varepsilon_s}(x + x_{p0})$$

$$E_0(x) = -\frac{qN_d}{\varepsilon_s}(x_{n0} - x)$$

- **E-Field zero outside of depletion region**
- **Note the asymmetrical depletion widths**
- **Which region has higher doping?**
- **Slope of E-Field larger in n-region. Why?**
- **Peak E-Field at junction.**

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Continuity of E-Field Across Junction

- Recall that E-field diverges on charge. For a sheet charge at the interface, the E-field could be discontinuous
- In our case, the depletion region is only populated by a background density of fixed charges so the E-Field is continuous
- What does this imply?

$$E_o^n(x=0) = -\frac{qN_a}{\varepsilon_s}x_{po} = -\frac{qN_d}{\varepsilon_s}x_{no} = E_o^p(x=0)$$

$$qN_a x_{po} = qN_d x_{no}$$

- Total fixed charge in n-region equals fixed charge in p-region! Somewhat obvious result.

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Potential Across Junction

- From our earlier calculation we know that the potential in the n-region is higher than p-region
- The potential has to smoothly transition form high to low when crossing the junction
- Physically, the potential difference is due to the charge transfer that occurs due to the concentration gradient
- Let's integrate the field to get the potential:

$$\phi(x) = \phi(-x_{po}) + \int_{-x_{p0}}^{x} \frac{qN_a}{\varepsilon_s}(x' + x_{po})dx'$$

$$\phi(x) = \phi_p + \frac{qN_a}{\varepsilon_s}\left(\frac{x'^2}{2} + x'x_{po}\right)\Bigg|_{-x_{p0}}^{x}$$

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