Lecture5:
Diode (3)

Sung-Min Hong (smhong@gist.ac.kr)

Semiconductor Device Simulation Lab.
School of Electrical Engineering and Coumputer Science
Gwangju Institute of Science and Technology

IV characteristics (1)

- Review
  - The diode current, I_D, is depedent on the diode voltage, V_D.
  - Then, what is $I_D(V_D)$?
- Compare $V_D = 0.3$ V, 0.4 V, and 0.5 V.
  - We know that the electric field for 0.5 V is weakest.
  - Of course, for 0.3 V, it is strongest.
  - Anyway, they are different by a constant voltage, 0.1 V.
  - Then, what about $I_D(0.3)$, $I_D(0.4)$, and $I_D(0.5)$?
  - Do you expect a linear dependence?

IV characteristics (2)

- Exponential dependence on V_D
  - V_D is normalized by the thermal voltage, $V_T = \frac{k_B T}{q}$.
  - At 300 K, $V_T \approx 0.002585\ \mathrm{V} = 25.85\ \mathrm{mV}$.
  - Then, the diode current can be written as

$$I_D = I_S \left(\exp \frac{V_D}{V_T} - 1 \right)$$

  - Here, the “reverse saturation current” (I_S) is a given constant. It’s a small current.

IV characteristics (3)

- Some limiting cases:

$$I_D = I_S\left(\exp\frac{V_D}{V_T} - 1\right)$$

  - When V_D is close to zero, $\exp\frac{V_D}{V_T} \approx 1 + \frac{V_D}{V_T}$

$$I_D = I_S\frac{V_D}{V_T}$$

  - When V_D is negative and $V_D \ll -V_T$, $\exp\frac{V_D}{V_T} \approx 0$

$$I_D = -I_S$$

  - When V_D is positive and $V_D \gg V_T$, $I_D = I_S \exp\frac{V_D}{V_T}$