Lecture 16
The pn Junction Diode (III)

Outline

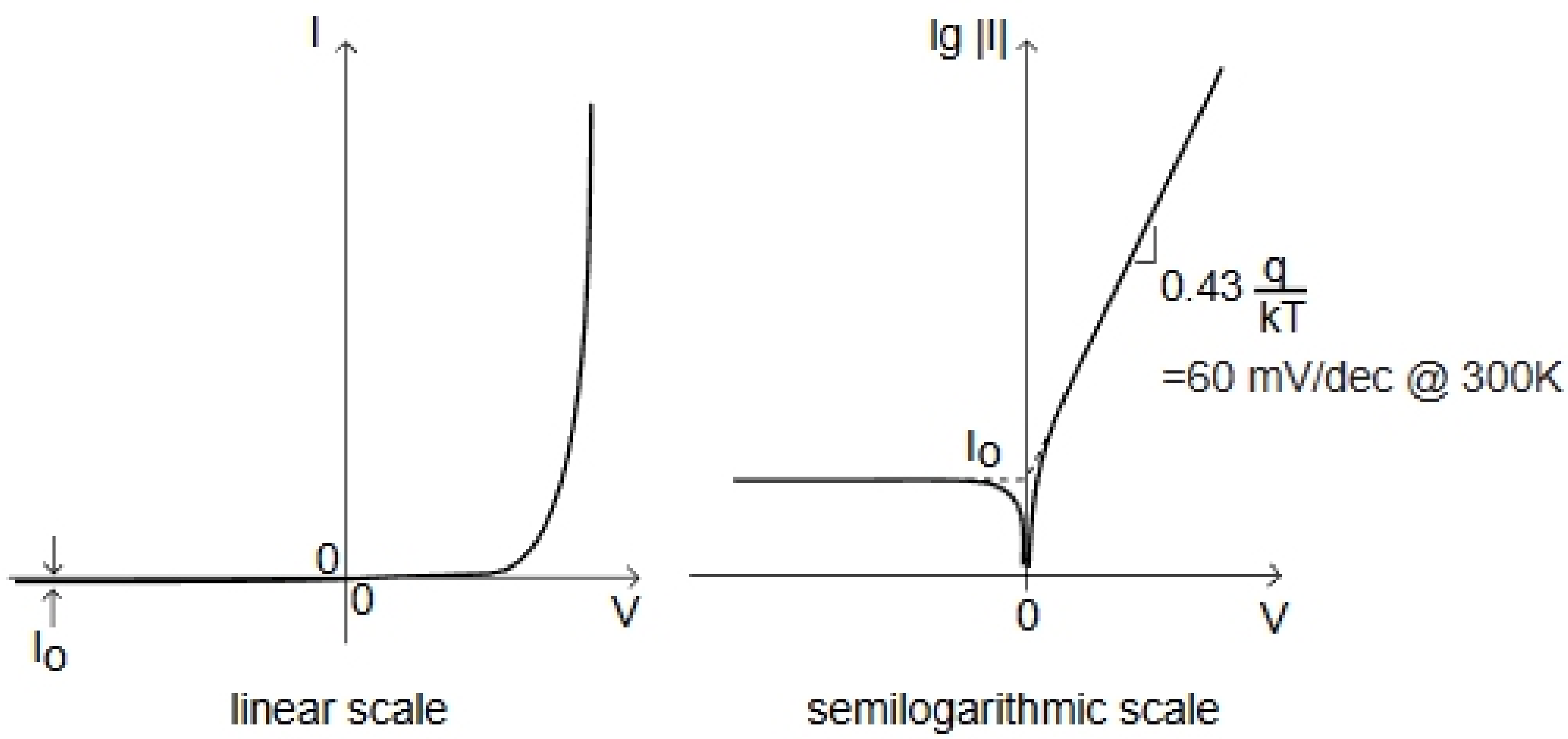
- Small-signal equivalent circuit model
- Carrier charge storage
  - –Diffusion capacitance

Reading Assignment:
Howe and Sodini; Chapter 6, Sections 6.4 - 6.5

I-V Characteristics

Diode Current equation:

$$I = I_o\left[e^{\left(\frac{V}{V_{th}}\right)} - 1\right]$$



2. Small-signal equivalent circuit model

Examine effect of small signal adding to forward bias:

$$I + i = I_o \left[e^{\left(\frac{q(V+v)}{kT}\right)} - 1 \right] \approx I_o e^{\left(\frac{q(V+v)}{kT}\right)}$$

If v small enough, linearize exponential characteristics:

$$I + i \approx I_o \left[e^{\left(\frac{qV}{kT}\right)} e^{\left(\frac{qv}{kT}\right)} \right] \approx I_o \left[e^{\left(\frac{qV}{kT}\right)} \left(1 + \frac{qv}{kT}\right) \right]$$

$$= I_o e^{\left(\frac{qV}{kT}\right)} + I_o e^{\left(\frac{qV}{kT}\right)} \frac{qv}{kT}$$

Then:

$$i = \frac{qI}{kT} \bullet v$$

From a small signal point of view. Diode behaves as *conductance* of value:

$$g_d = \frac{qI}{kT}$$