Lecture 5

ANNOUNCEMENTS

- HW1 will be considered as extra credit.
- HW3 is posted, due Tuesday 9/18

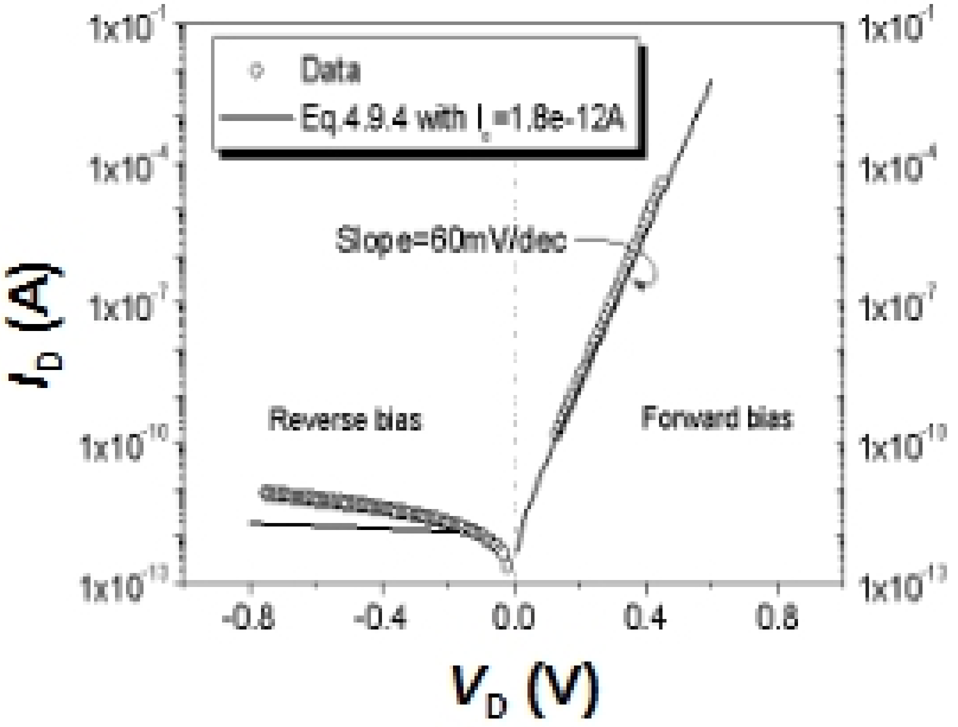
OUTLINE

- BJT (cont'd)
  - Transconductance
  - Small-signal model
  - The Early effect
  - BJT operation in saturation mode

Reading: Chapter 4.4.3-4.5

Notes on PN Junctions

- Typically, pn junctions in IC devices are formed by counter-doping. The equations provided in class (and in the textbook) can be readily applied to such diodes if
  - $N_A \equiv$ net acceptor doping on p-side $(N_A\text{-}N_D)_{\text{p-side}}$
  - $N_D \equiv$ net donor doping on n-side $(N_D\text{-}N_A)_{\text{n-side}}$

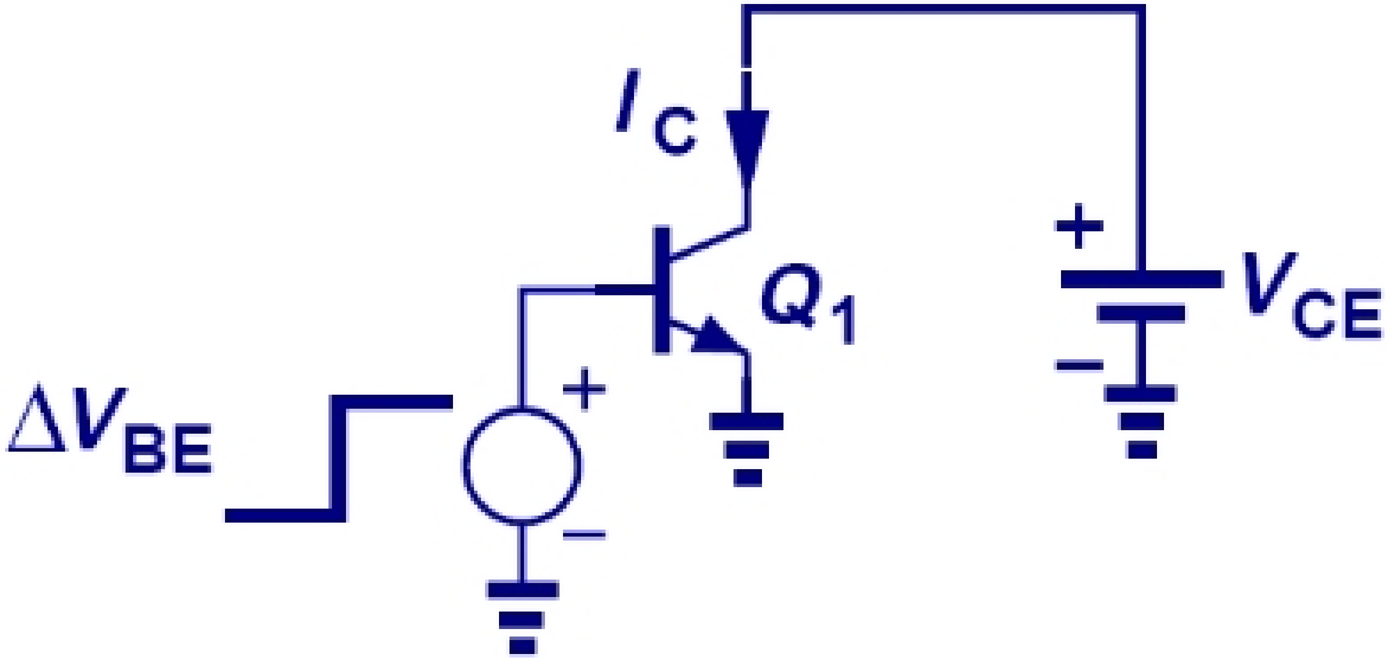


$$I_D = I_S\left(e^{qV_D/kT} - 1\right)$$

$$I_S = Aqn_i^{\,2}\left[\frac{D_n}{L_n N_A} + \frac{D_p}{L_p N_D}\right]$$

Transconductance, g_m

- The ***transconductance*** (g_m) of a transistor is a measure of how well it converts a voltage signal into a current signal.
- It will be shown later that g_m is one of the most important parameters in integrated circuit design.



$$g_m \equiv \frac{dI_C}{dV_{BE}} \cong \frac{d}{dV_{BE}}\left[I_S \exp\frac{V_{BE}}{V_T}\right]$$

$$g_m = \frac{1}{V_T} I_S \exp\frac{V_{BE}}{V_T}$$

$$g_m = \frac{I_C}{V_T}$$