Bipolar Transistor - Lecture 12

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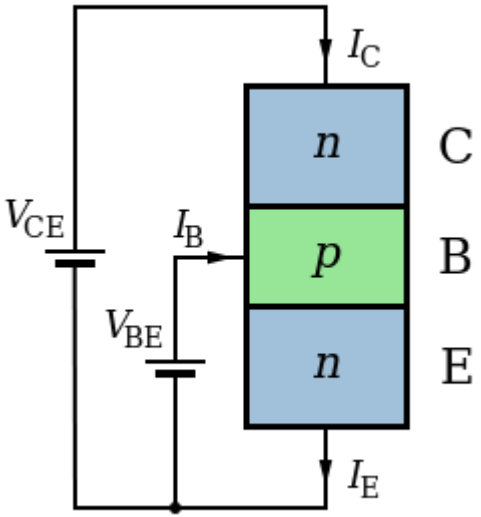
From Before

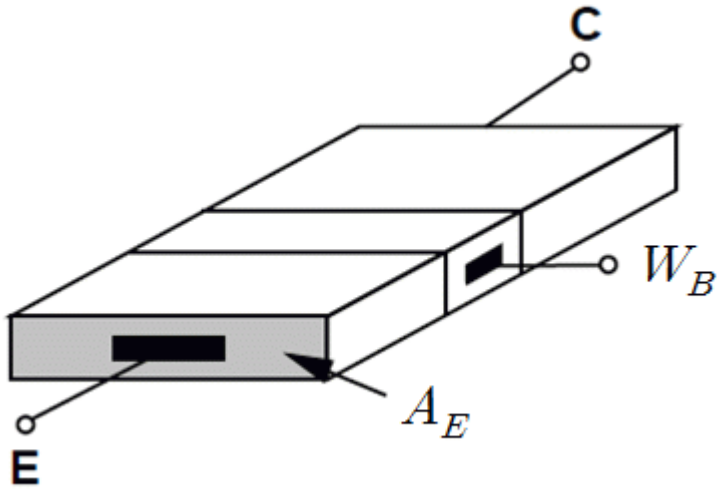
- Active Forward Bias(Region)



By KVL

$$V_{CB} = V_{CE} - V_{BE} \geq 0$$

Collector Current



$$I_s = \frac{A_E q n_i^2 D_n}{W_B N_B}$$

- A_E -> Emitter Area
- W_B -> Base Width
- N_B -> Doping in Base

Collector Current

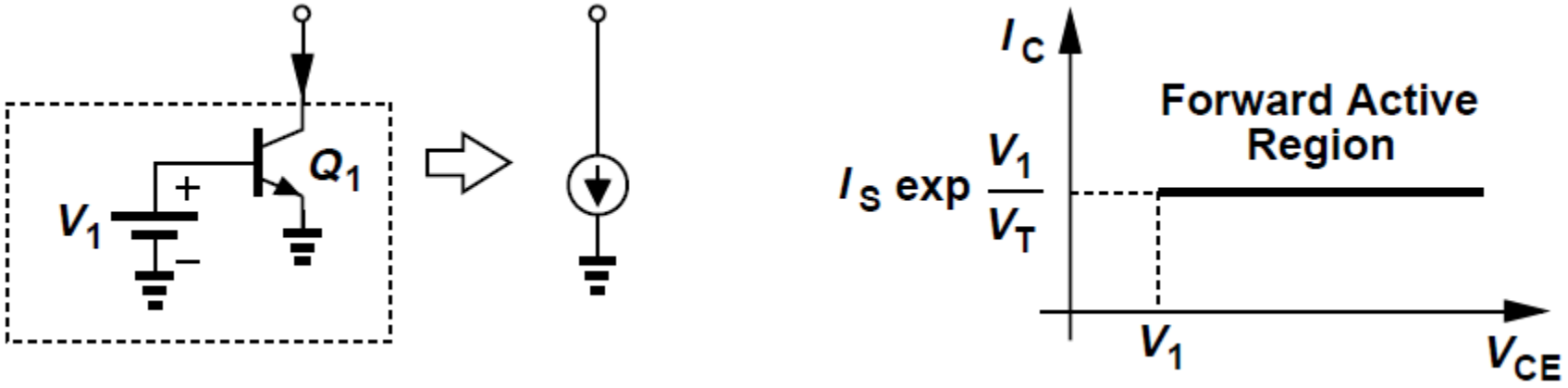
$$I_c = I_s \exp\left(\frac{V_{BE}}{V_T} - 1\right)$$

- In most case the -1 can be negligible.

$$I_c = I_s \exp\left(\frac{V_{BE}}{V_T}\right) => V_{BE} = V_T \ln\frac{I_C}{I_s}$$

I_C vs V_{CE}

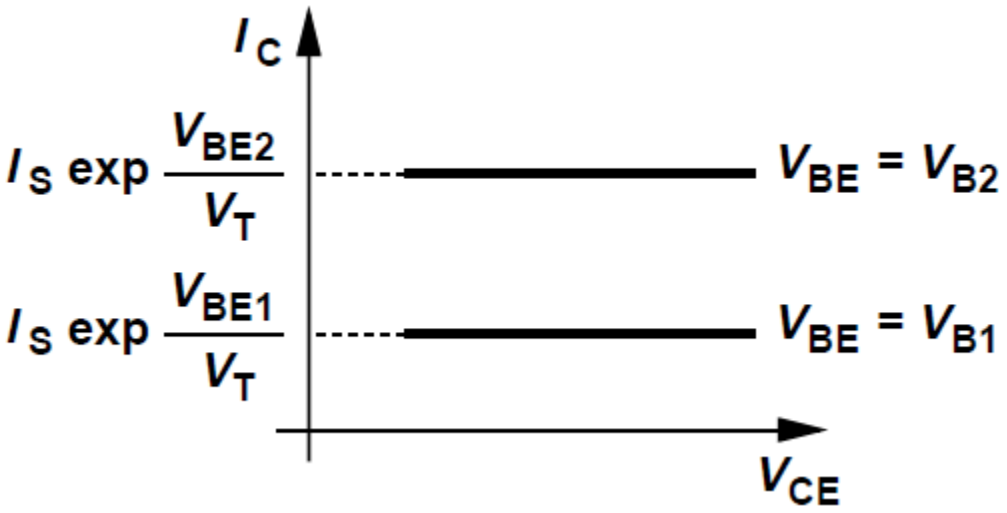
- First, consider I_C with V_{BE}=const.



- It behaves like voltage-dependent current source.

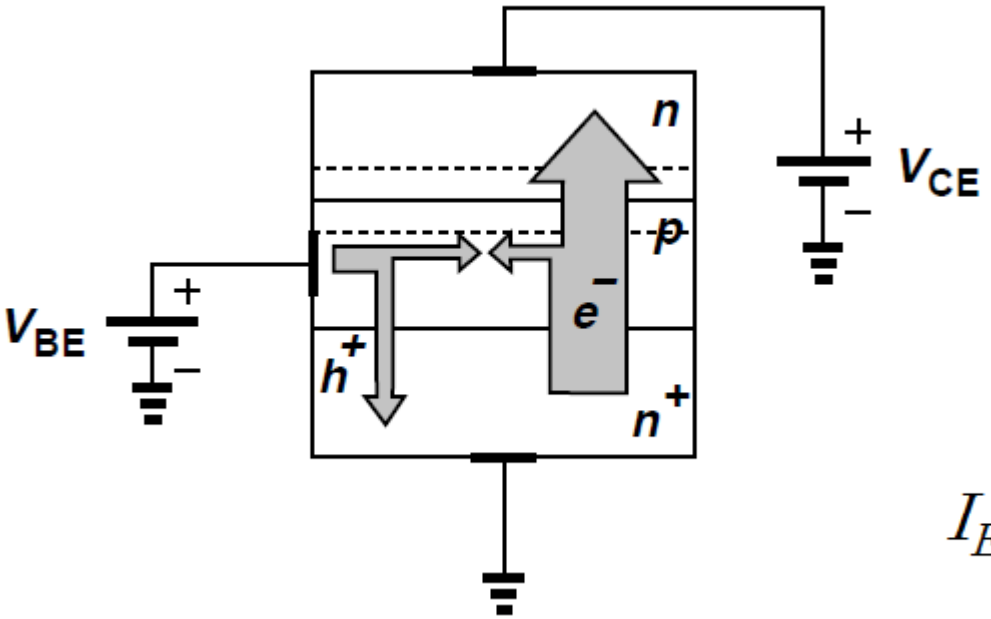
I_C vs V_{CE}

- When V_{BE} changes.



I_C vs V_{CE}

- I_B is proportional to I_C



$$I_C = \beta I_B$$

By KCL

$$I_E = I_C + I_B$$

$$= \left(1 + \frac{1}{\beta}\right) I_C$$

$$I_E = \frac{\beta + 1}{\beta} exp\left(\frac{V_{BE}}{V_T}\right)$$

$$I_C \simeq I_E$$

Thank you