ECE 523/421 – Analog Electronics

Lecture 4: Basic BJT Amplifiers I

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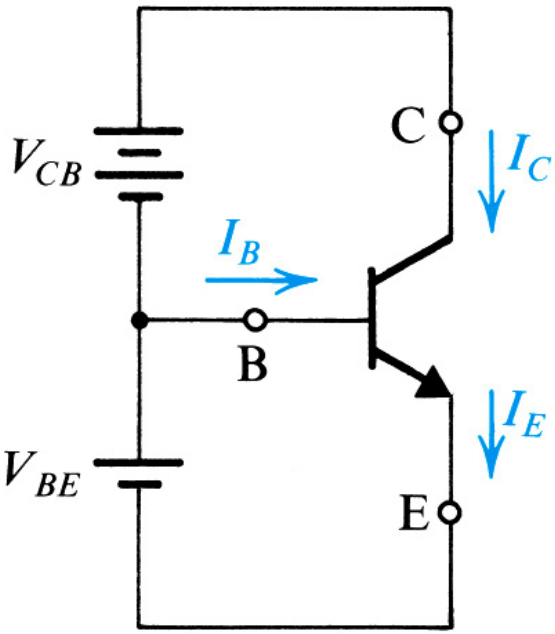
Review of Last Lecture

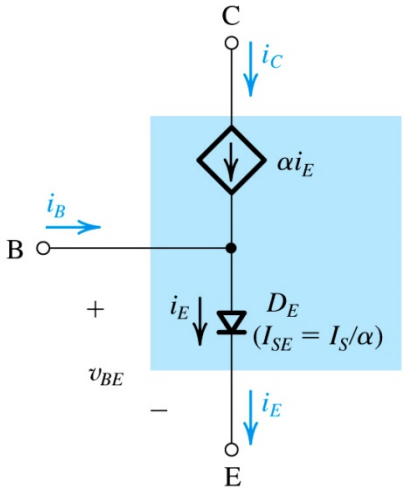
- **Biasing in MOS Amplifier Circuits**
  - **Fix V_{GS} Biasing**
  - **Fix V_{GS} Biasing with Source Resistance**
  - **Drain-to-Gate Feedback Resistor Biasing**
  - **Constant Current Source Biasing**
- **Role of Body Effect in MOS Amplifiers**
- **Temperature Effect**

Today's Lecture

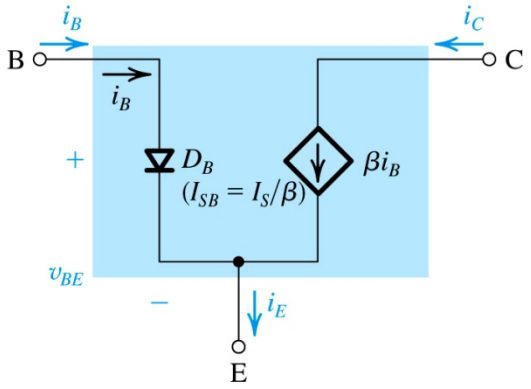
- **Basic BJT Characteristics**
- **DC analysis on BJT Circuits**

Basic Bipolar Device





T Model

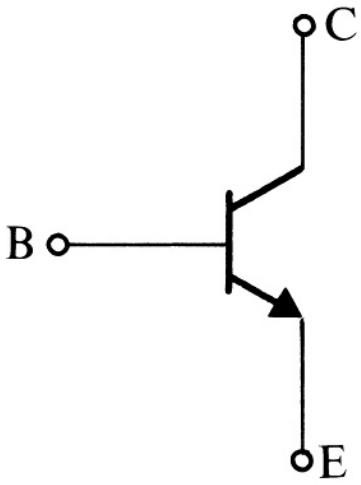


Π Model

BJT & MOSFET Comparison

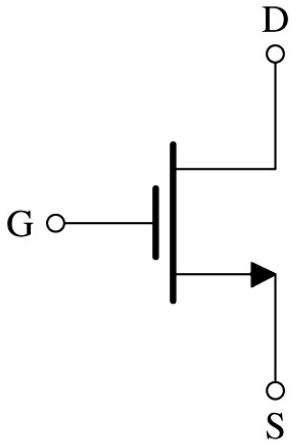
BJT

- V_{BE} is always constant (~0.7V)
- $V_{CE(sat)}$ is always constant (~0.2V)
- I_B is small BUT not zero
- I_C is computed form I_B
- Less parameters to play with



MOSFET

- V_{GS} is not constant (depends on V_{OV})
- $V_{DS(min)}$ is not constant depends on V_{OV})
- I_G is always zero
- I_D is computed form V_{OV}
- More parameters to play with (V_{OV}, W, and L)



Summary of Equations for BJT

Table 6.1 Summary of the BJT Current–Voltage Relationships in the Active Mode

$$i_C = I_S e^{v_{BE}/V_T}$$

$$i_B = \frac{i_C}{\beta} = \left(\frac{I_S}{\beta}\right) e^{v_{BE}/V_T}$$

$$i_E = \frac{i_C}{\alpha} = \left(\frac{I_S}{\alpha}\right) e^{v_{BE}/V_T}$$

Note: For the *pnp* transistor, replace v_{BE} with v_{EB}.

$$i_C = \alpha i_E \qquad i_B = (1-\alpha) i_E = \frac{i_E}{\beta+1}$$

$$i_C = \beta i_B \qquad i_E = (\beta+1) i_B$$

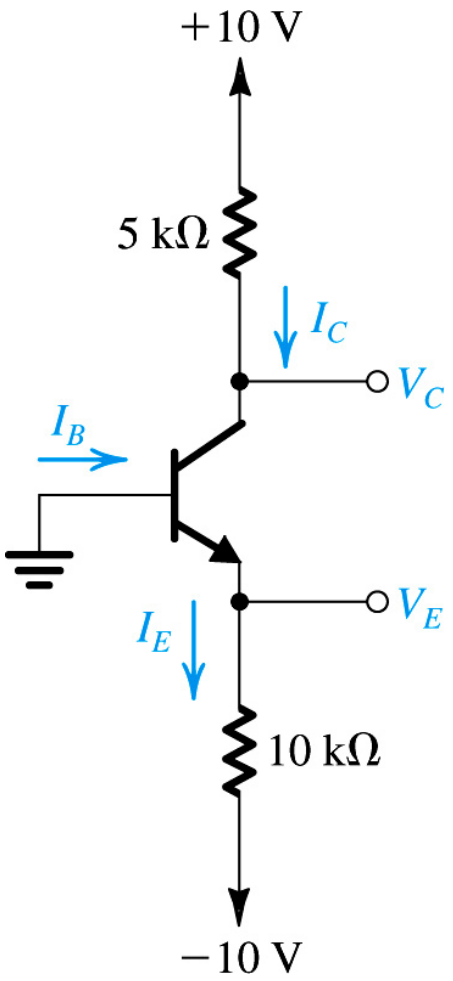
$$\beta = \frac{\alpha}{1-\alpha} \qquad \alpha = \frac{\beta}{\beta+1}$$

V_T = thermal voltage $= \dfrac{kT}{q} \approx 25$ mV at room temperature

And similar to MOSFET: $$r_o = \frac{V_A}{I_C}$$

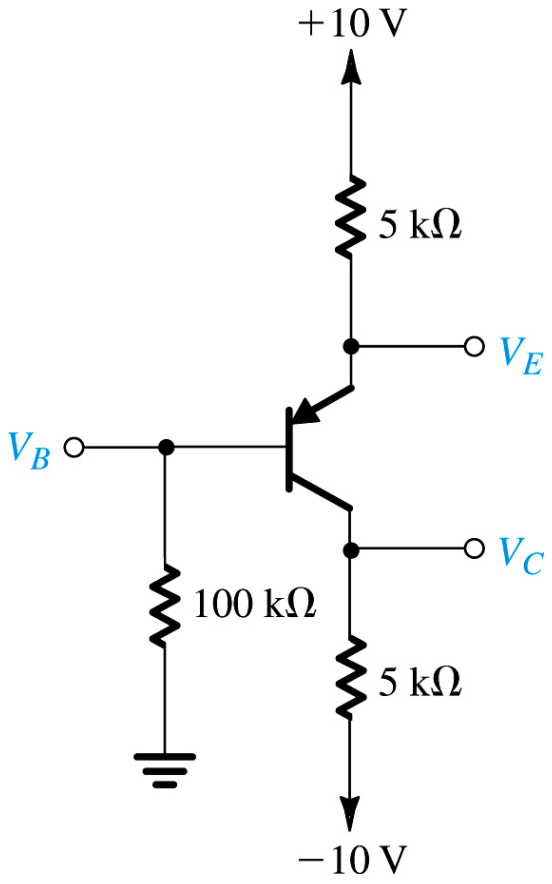
Example: Bias Circuit Design I

1) Find I_C, I_B, I_E, V_C and V_E.



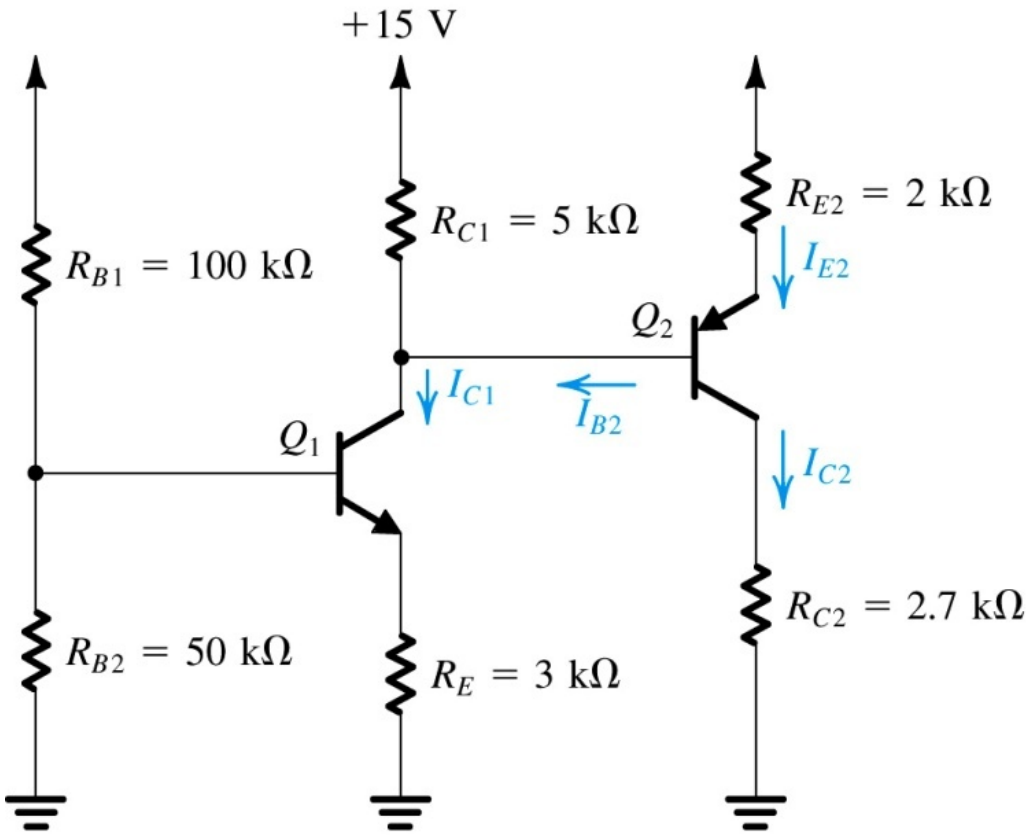
Example: Bias Circuit Design II

1) If V_B=1V and V_E=1.7V, find α, β, and V_C.



Example: Bias Circuit Analysis I

1) Analyze the following circuit. Assume that β=100 for both transistors.



Example: Bias Circuit Analysis II

1) Analyze the following circuit. Assume that β=100 for both transistors.