BJT Biasing Circuits

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Some figures of this presentation were taken from the instructional resources of the following textbooks:

A. S. Sedra and K. C. Smith, *Microelectronic Circuits*. New York, NY: Oxford University Press, 2003.

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Outline

- Biasing a BJT
- Examples of biasing circuits
- Stability of the bias point
- Examples of stabilizing bias points

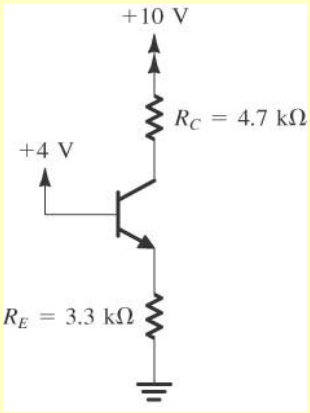
Biasing a Bipolar Transistor

- A BJT can be biased in any of its operational regions

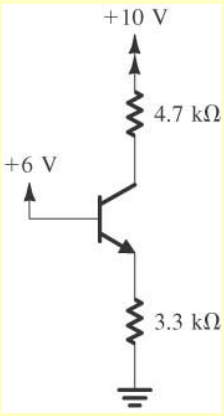
		Collector-Base Junction (CB)	
		Forward-biased	Reversed-biased
Base-Emitter Junction (BE)	Forward-biased	**Saturation Region** (switch on)	**Active Region** (good amplifier)
	Reversed-biased	**Inverted Active Region** (poor amplifier)	**Cutoff Region** (switch off)

- For most applications, BJTs are biased in the active region
- The bias point is also called the operation point, and is defined by the transistor DC voltages and currents

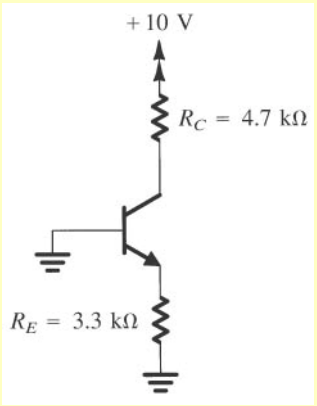
BJT Biasing Circuits – Example 1



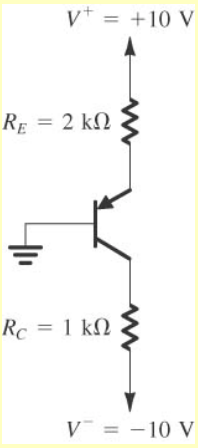
BJT Biasing Circuits – Example 2



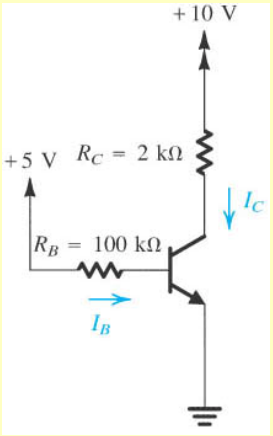
BJT Biasing Circuits – Example 3



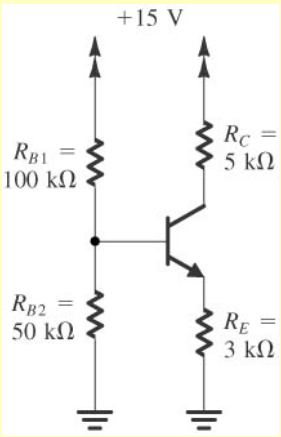
BJT Biasing Circuits – Example 4



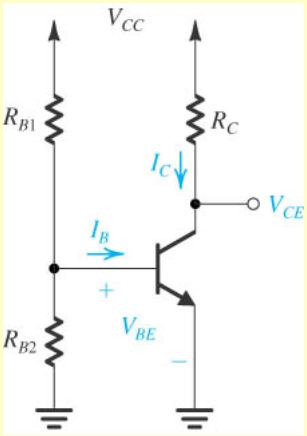
BJT Biasing Circuits – Example 5



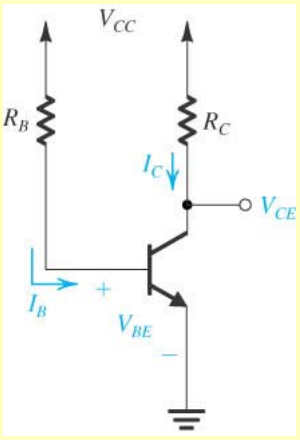
BJT Biasing Circuits – Example 6



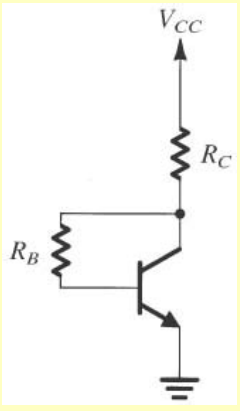
BJT Biasing Circuits – Example 7



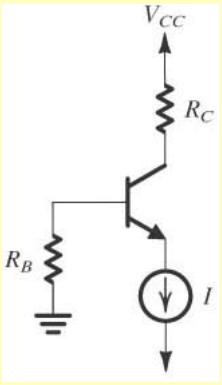
BJT Biasing Circuits – Example 8



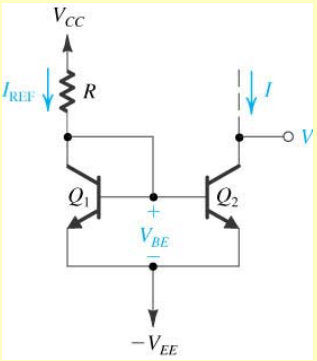
BJT Biasing Circuits – Example 9



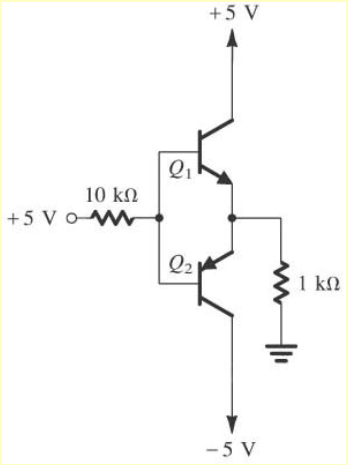
BJT Biasing Circuits – Example 10



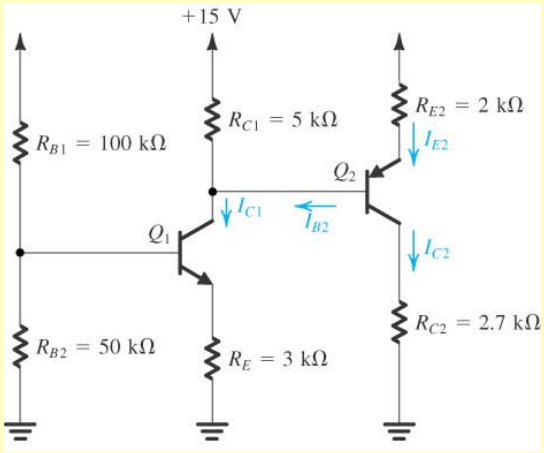
Current source I can be implemented by:



BJT Biasing Circuits – Example 11



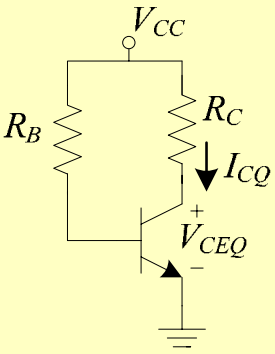
BJT Biasing Circuits – Example 12



Bias Stability

- A bias point is stable if it is little sensitive to variations of BJT internal parameters, mainly β and V_{BE}
- The bias point stability depends on the biasing circuit topology and element values
- Some biasing circuits can be made more stable than others

Making a Bias Point Stable – Example 1



$$V_{CEQ} = V_{CC} - I_{CQ}R_C$$

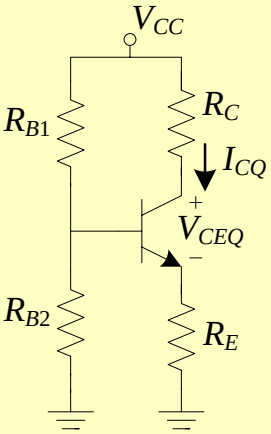
$$I_{CQ} = \beta \frac{V_{CC} - V_{BE}}{R_B}$$

Making $V_{CC} >> V_{BE}$

$$I_{CQ} \approx \beta \frac{V_{CC}}{R_B}$$

This biasing circuit can make the bias point stable against variations in V_{BE} only

Making a Bias Point Stable – Example 2



$$V_{TH} = \frac{R_{B2}V_{CC}}{R_{B1} + R_{B2}} \qquad R_{TH} = R_{B1} \parallel R_{B2}$$

$$V_{CEQ} = V_{CC} - I_{CQ}(R_E + R_C)$$

$$I_{CQ} = \frac{V_{TH} - V_{BE}}{\frac{R_{TH}}{\beta} + R_E}$$

Making $R_E >> R_{TH}/\beta$ and $V_{TH} >> V_{BE}$

$$I_{CQ} \approx \frac{V_{TH}}{R_E}$$

This biasing circuit can make the bias point stable against variations in V_{BE} and β