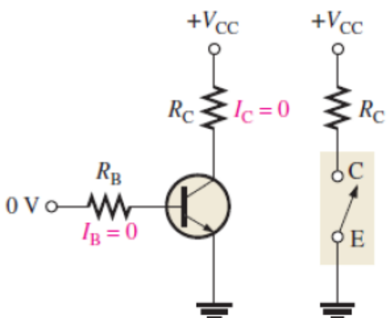
Chapter.5

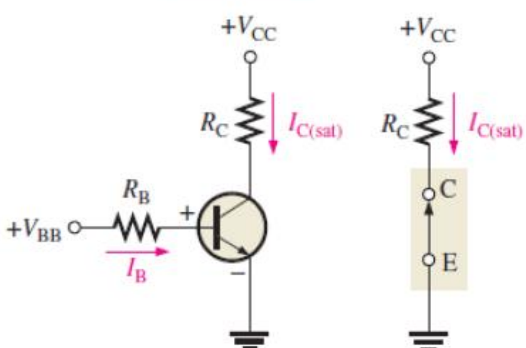
Transistor Bias Circuits

BJT as a Switch

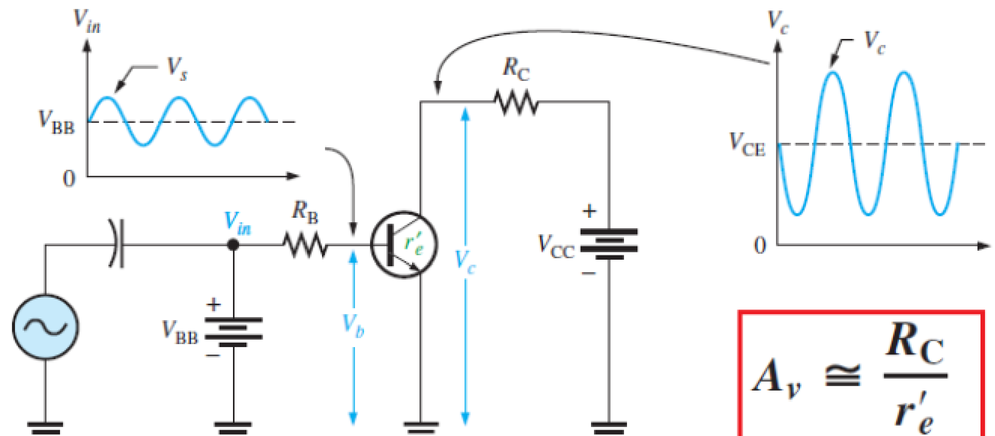
(a) Cutoff - open switch



(b) Saturation - closed switch



BJT as an Amplifier



$$A_v \cong \frac{R_C}{r'_e}$$

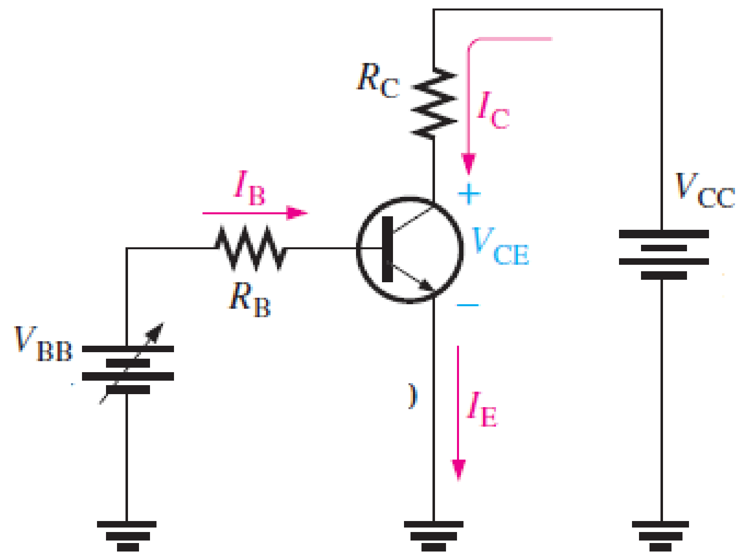
DC Bias

- A transistor must be properly biased with a dc voltage in order to operate as a linear amplifier.

- The purpose of biasing a circuit is to establish a proper stable dc operating point **Q-point (V_{CE} , I_C).**

- A dc operating point must be set so that signal variations at the input terminal are amplified and accurately reproduced at the output terminal.

DC biased circuit

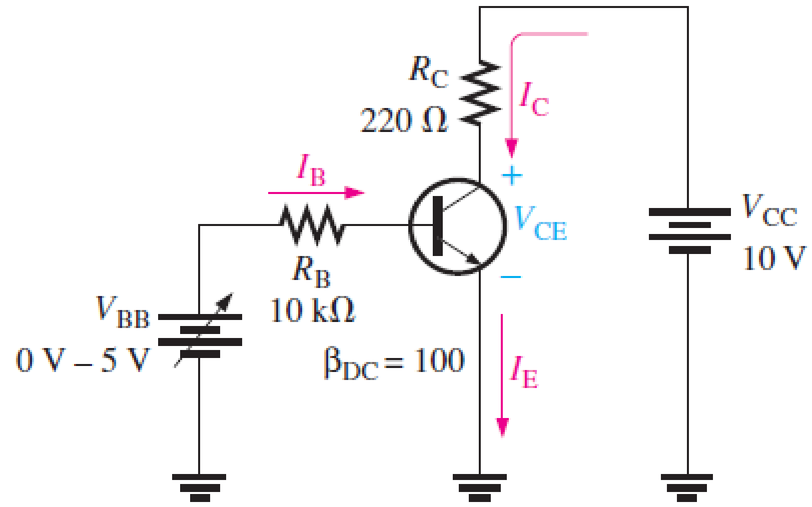


Graphical Analysis of DC Biasing

- The transistor is biased with V_{CC} and V_{BB} to obtain certain values of I_B, I_C, I_E, and V_{CE}.

- The **collector characteristic curves** are shown to illustrate the effects of dc bias.

- By varying I_B ,we can obtain several Q-points.

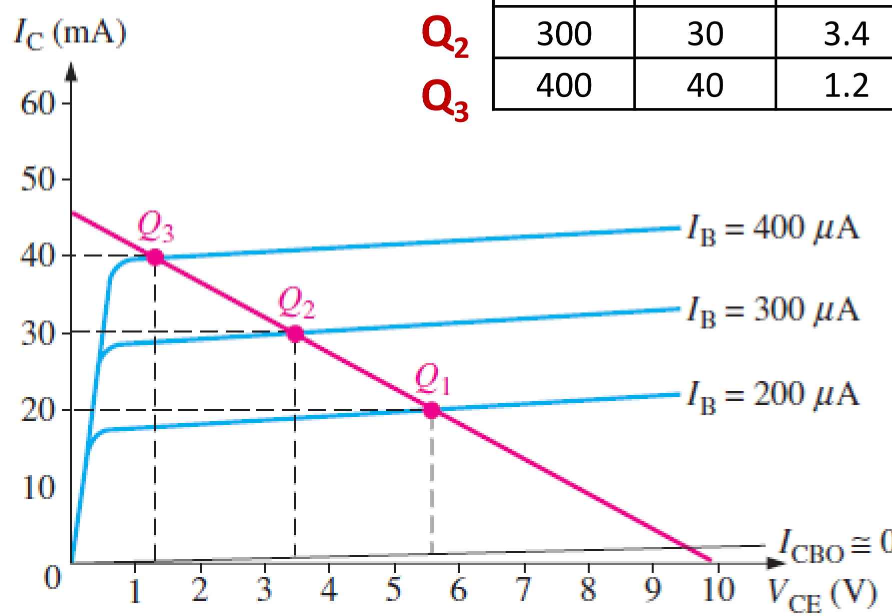


(a) DC biased circuit

	I_B (μA)	I_C(mA)	V_{CE}(V)
Q_1	200	20	5.6
Q_2	300	30	3.4
Q_3	400	40	1.2

- **DC load line** passes through the Q-point on a transistor's collector curves intersecting the vertical axis at approximately $\mathbf{I_{C(sat)}}$ and the horizontal axis at $\mathbf{V_{CE(off)}}$.

$$I_{C(sat)} = V_{CC} - V_{CE(sat)} / R_C = 45.5 \text{ mA}$$



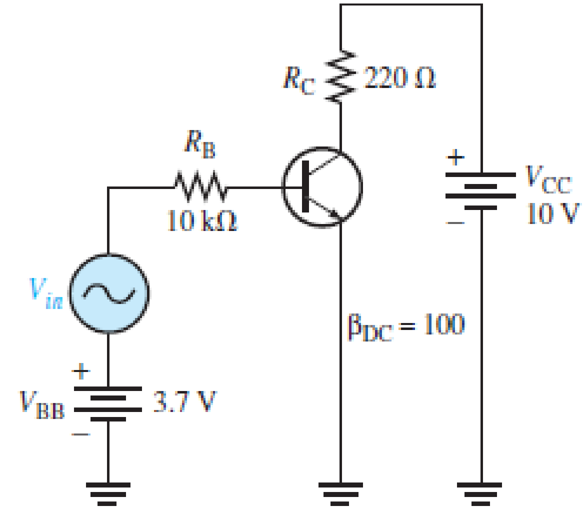
(b) The dc load line.

Linear Operation

- The region along the load line including all points between saturation and cutoff is generally known as the **linear region** of the transistor's operation.

- The output voltage is ideally a linear reproduction of the input.

- **Q-Point**: (V_{CEQ} = **3.4 V**, I_{CQ}= **30 mA**)

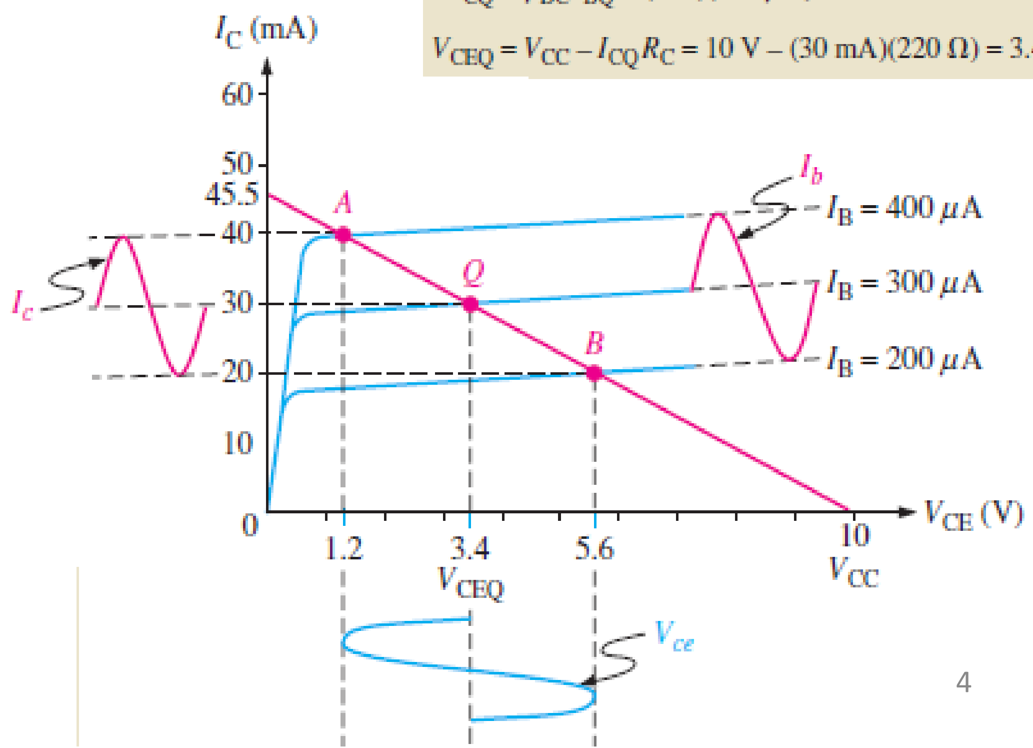


$$I_{BQ} = \frac{V_{BB} - 0.7\text{ V}}{R_B} = \frac{3.7\text{ V} - 0.7\text{ V}}{10\text{ k}\Omega} = 300\ \mu\text{A}$$

$$I_{CQ} = \beta_{DC} I_{BQ} = (100)(300\ \mu\text{A}) = 30\text{ mA}$$

$$V_{CEQ} = V_{CC} - I_{CQ}R_C = 10\text{ V} - (30\text{ mA})(220\ \Omega) = 3.4\text{ V}$$

- Assume sinusoidal voltage, $\mathbf{V_{IN}}$, is superimposed on $\mathbf{V_{BB}}$, causing the base current to vary sinusoidally **100 µA** above and below its Q-point value of **300 µA**.



- This causes the collector current to vary **10 mA** above and below its Q-point value of **30 mA**.

- The collector to-emitter voltage varies **2.2 V** above and below its Q-point value of **3.4 V**.