Lecture (01)
Transistor operating point & DC Load line

By:

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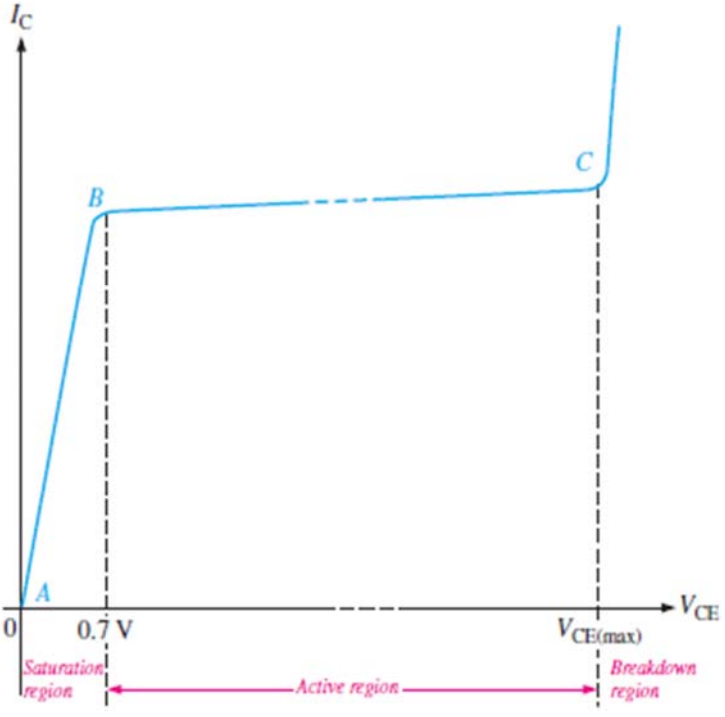
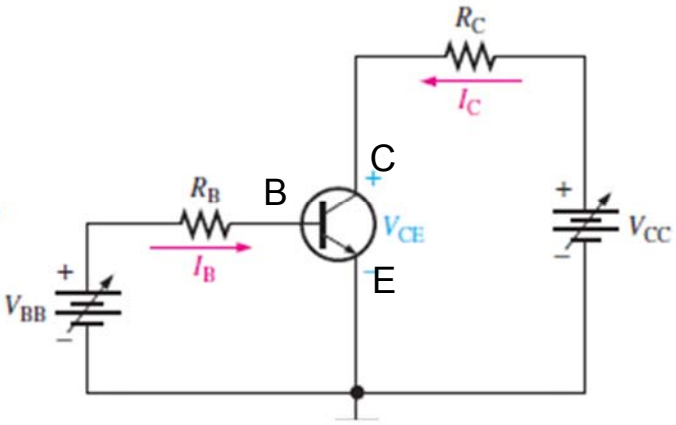
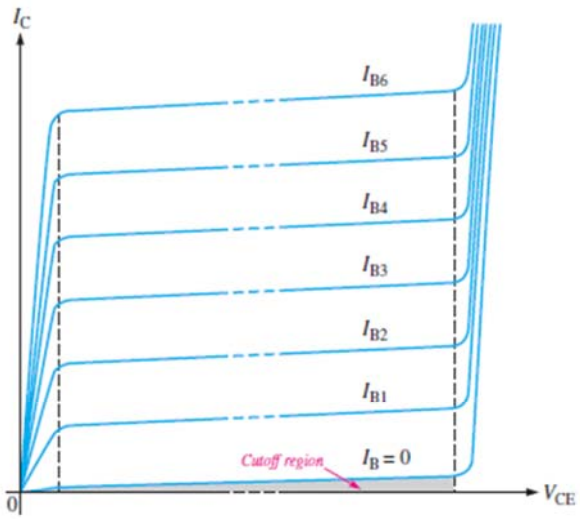
BJT Characteristic

Collector Characteristic Curves







(c) Family of I_C versus V_{CE} curves for several values of I_B ($I_{B1} < I_{B2} < I_{B3}$, etc.)

BJT modes of operation

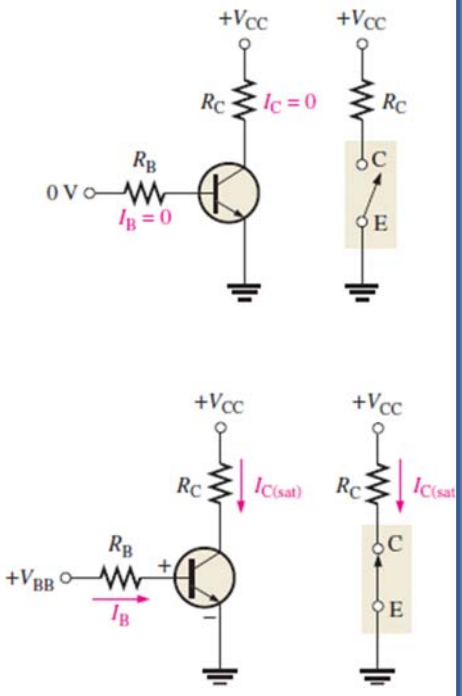
- ***Conditions in Cutoff***

$$V_{CE(cutoff)} = V_{CC}$$

- ***Conditions in Saturation***

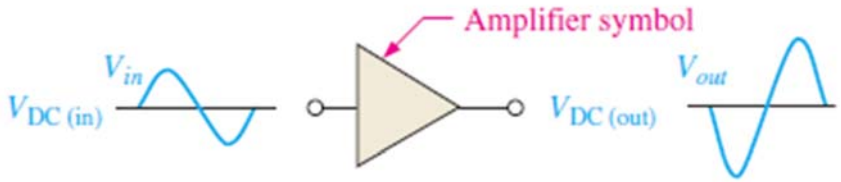
$$I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)}}{R_C}$$

$$I_{B(min)} = \frac{I_{C(sat)}}{\beta_{DC}}$$



DC Bias

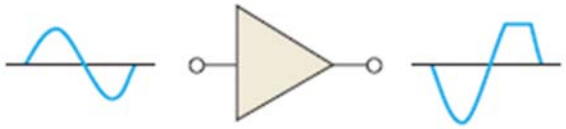
- Following Figure shows the effects of proper and improper dc biasing of an inverting amplifier.



(a) Linear operation: larger output has same shape as input except that it is inverted

which means that it is
out of phase with the input.
The output signal swings equally above
and below the dc bias
level of the output, *V*DC(out).

- If an amplifier is not biased with correct dc voltages on the input and output, it can go into saturation or cutoff when an input signal is applied
- Improper biasing can cause distortion in the output signal



(b) Nonlinear operation: output voltage limited (clipped) by cutoff

Figure illustrates limiting of the positive portion of the output voltage as a result of a Q-point (dc operating point) being too close to cutoff

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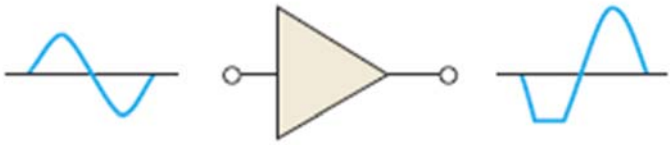
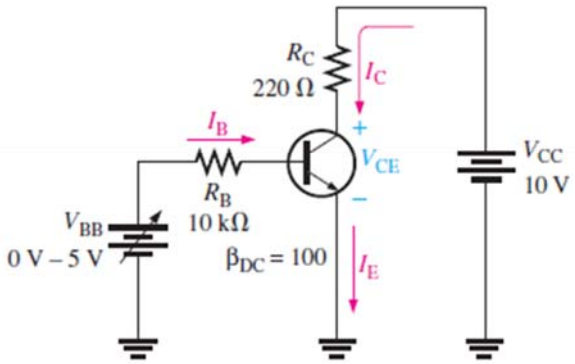


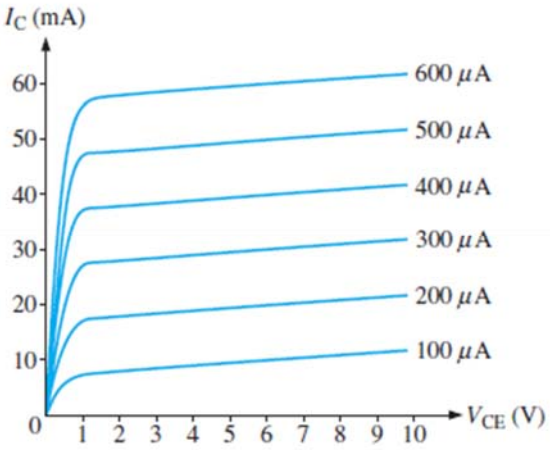
(c) Nonlinear operation: output voltage limited (clipped) by saturation

limiting of the negative portion of the output voltage as a result of a dc operating point being too close to saturation.

- The transistor in Figure is biased with *V*CC and *V*BB to obtain certain values of *I*B, *I*C, and *V*CE.

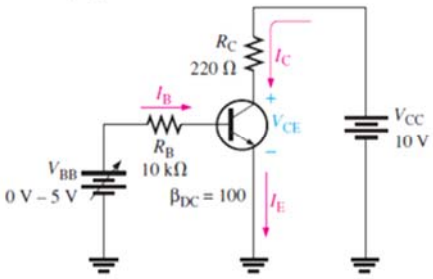


(a) DC biased circuit



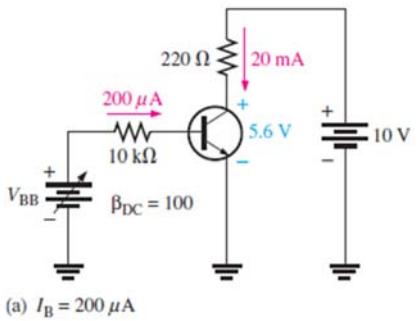
(b) Collector characteristic curves

- assign three values to *I*B and observe what happens to *I*C and *V*CE.
- V_{BB} is adjusted to produce an *I*B of 200 uA
- Since $I_C = \beta I_B$
- the collector current is 20 mA,

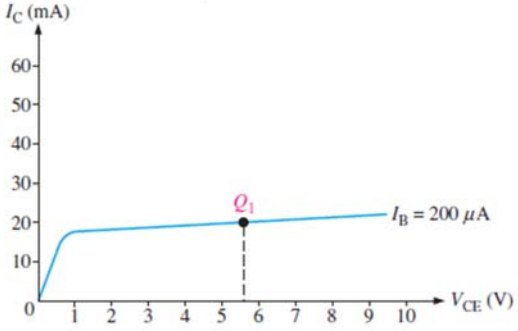


$$V_{CE} = V_{CC} - I_C R_C = 10\,\text{V} - (20\,\text{mA})(220\,\Omega) = 10\,\text{V} - 4.4\,\text{V} = 5.6\,\text{V}$$

- This Q-point is shown on the graph of Figure

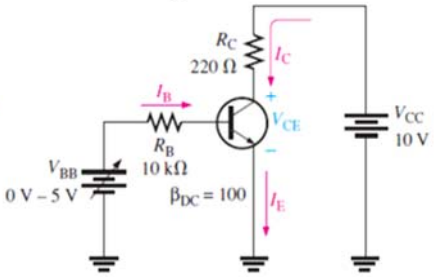


(a) $I_B = 200\,\mu\text{A}$

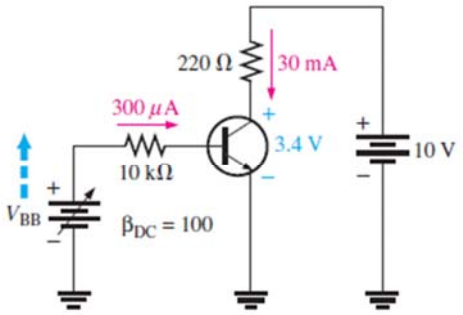


- V_{BB} is increased to produce an I_B of 300 uA and an I_C of 30 mA.

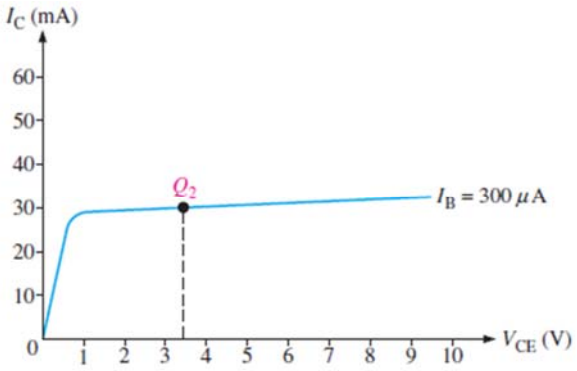
$$V_{CE} = 10\,\text{V} - (30\,\text{mA})(220\,\Omega) = 10\,\text{V} - 6.6\,\text{V} = 3.4\,\text{V}$$



- The Q-point for this condition is indicated by *Q*2 on the graph

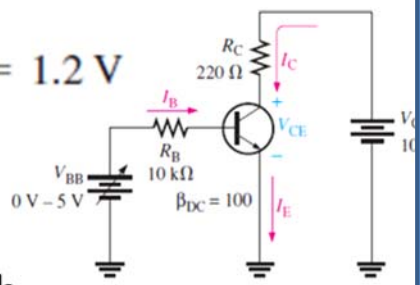


(b) Increase I_B to 300 μA by increasing V_{BB}

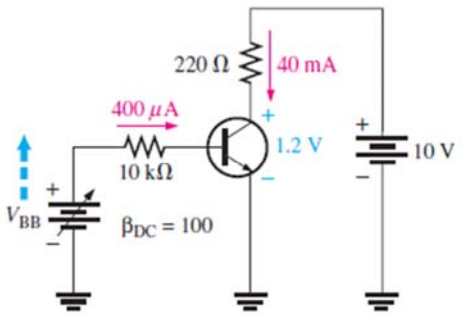


- *V*BB is increased to give an I_B 400 uA of and an *I*C of 40 mA.

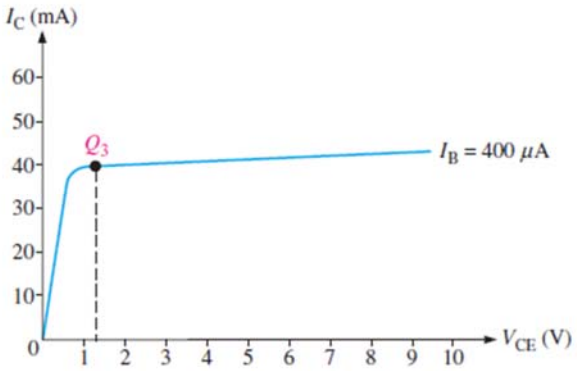
$$V_{CE} = 10\,\text{V} - (40\,\text{mA})(220\,\Omega) = 10\,\text{V} - 8.8\,\text{V} = 1.2\,\text{V}$$



- Q3 is the corresponding Q-point on the graph.



(c) Increase I_B to 400 μA by increasing V_{BB}




Thanks,..
See you next week (ISA),…