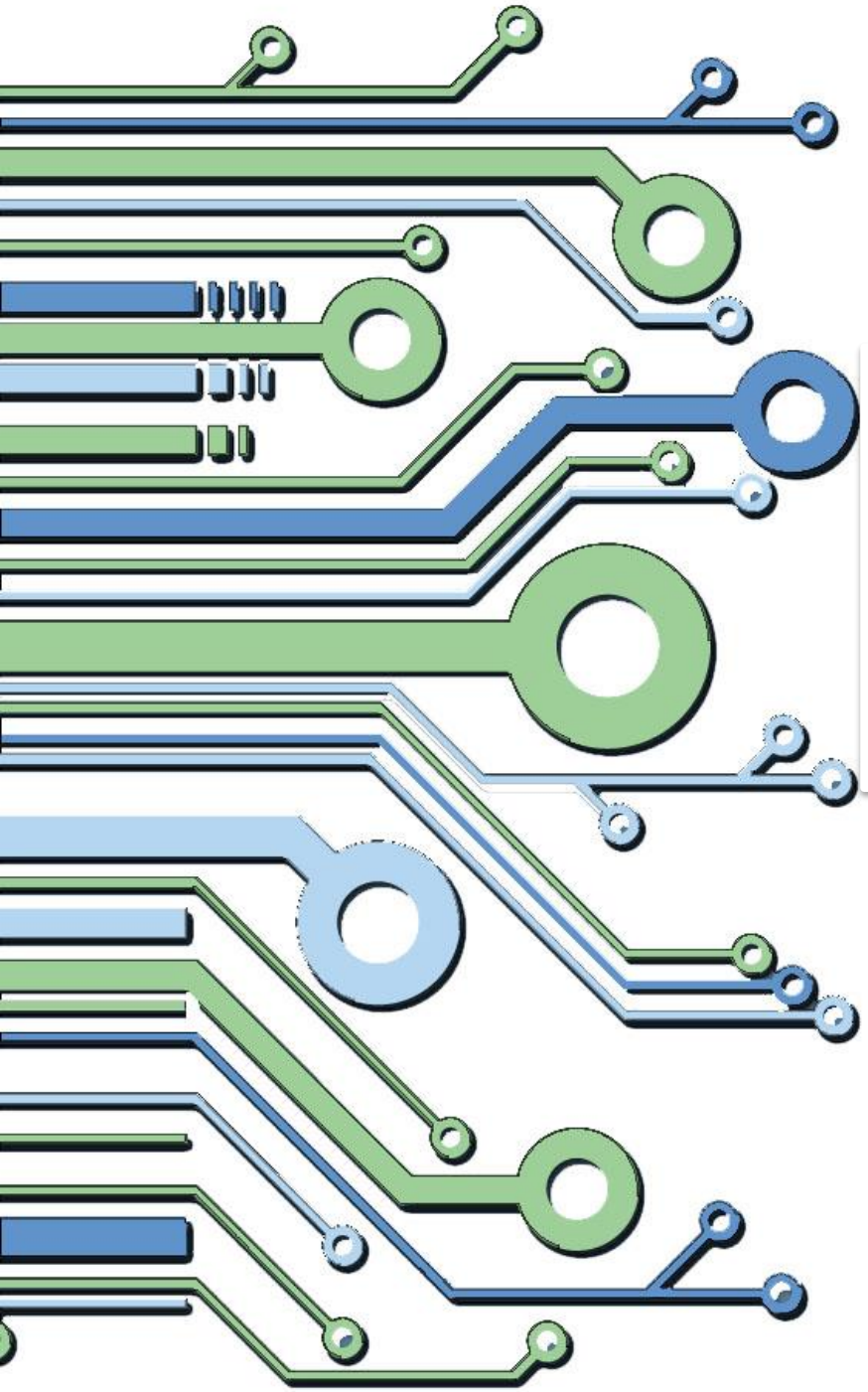
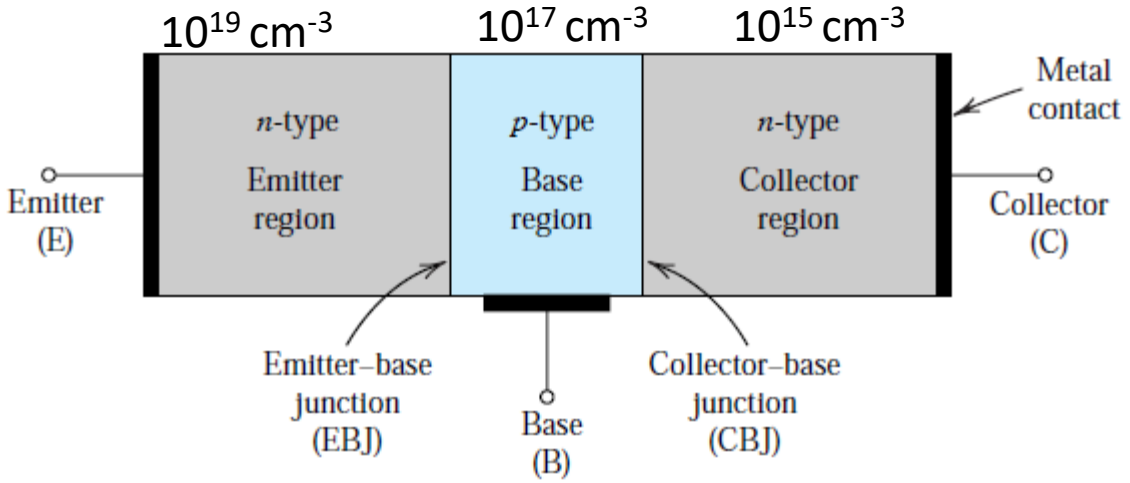
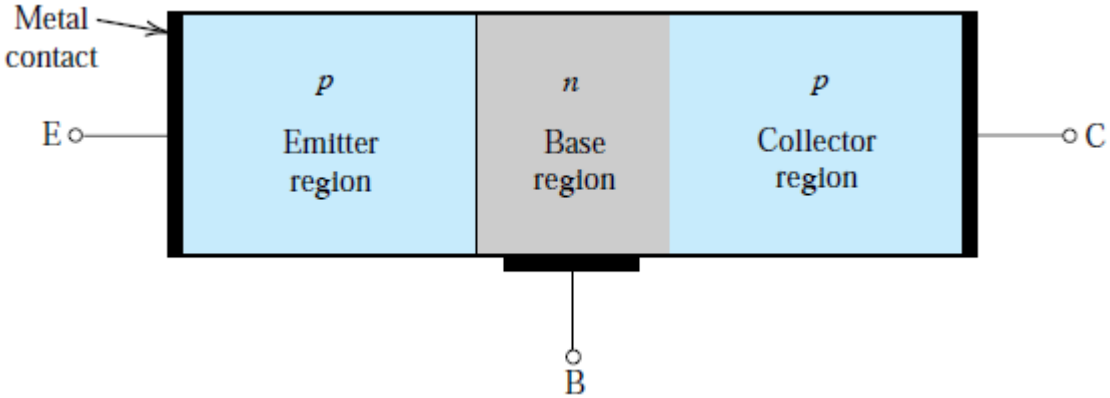


Bipolar Junction Transistor

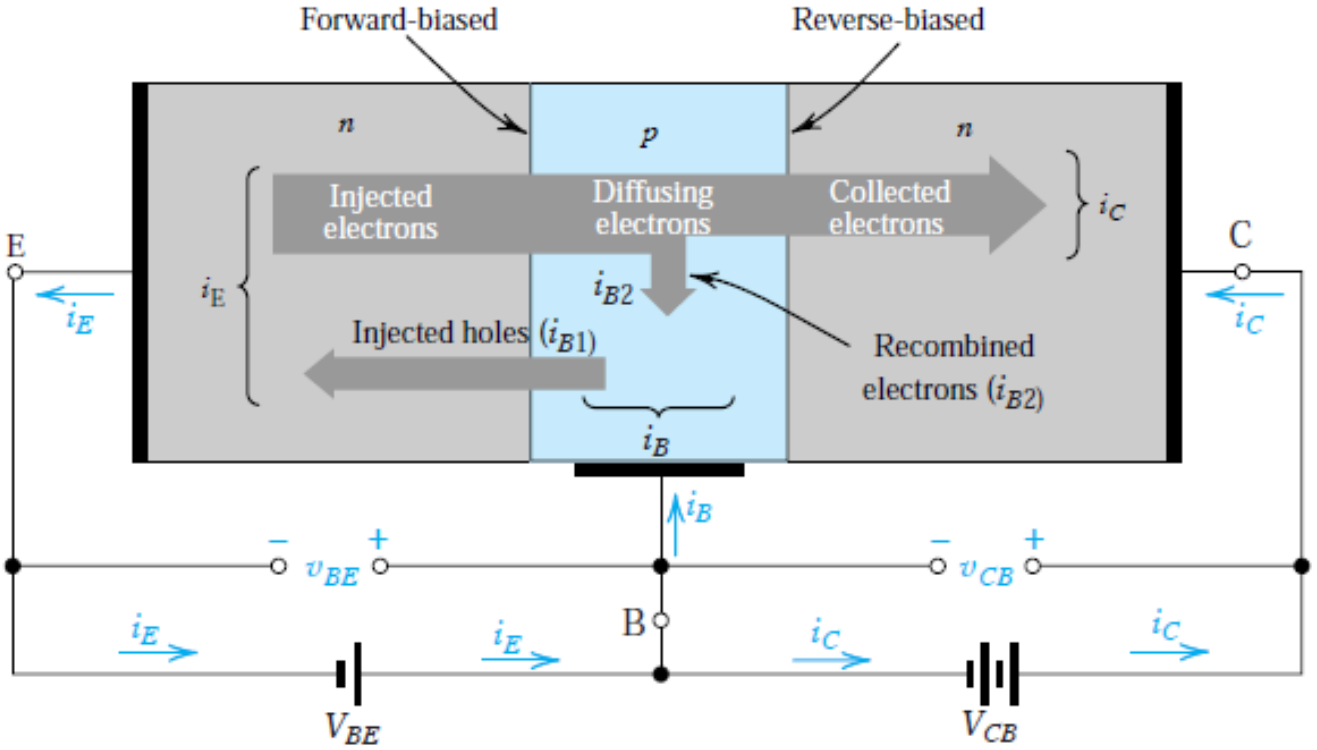
BY:
Dr. M. Shiple

Simplified Structure Of BJT





Current Flow in *NPN Transistor*

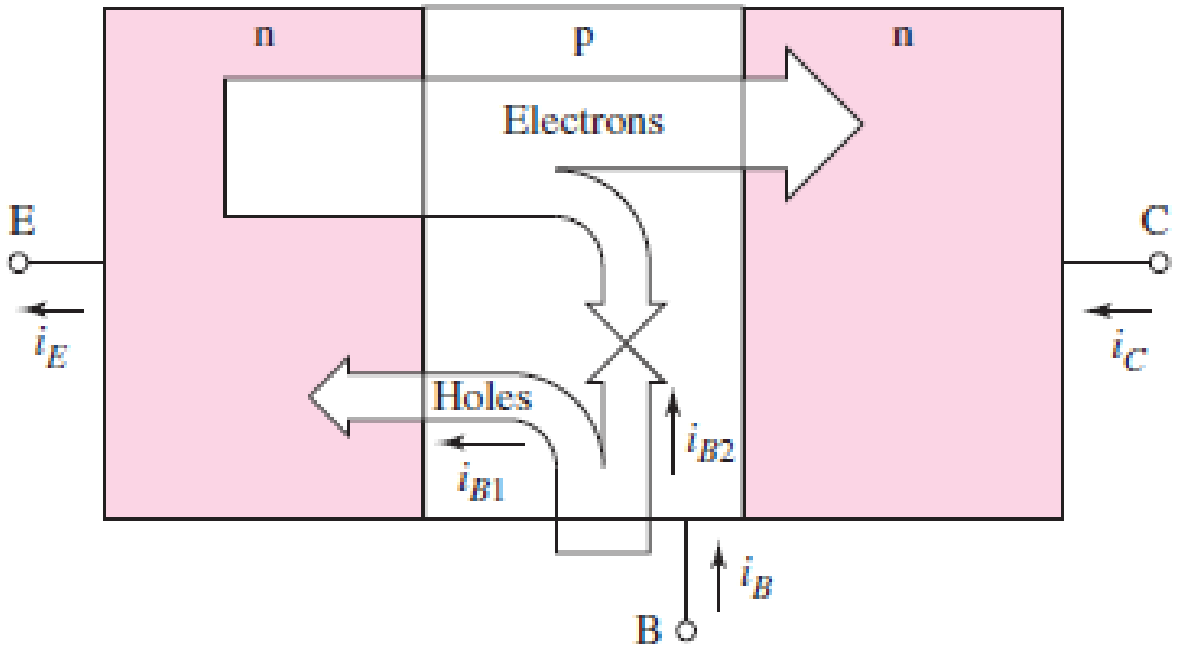


Saturation current

The Collector Current: $i_C = I_S e^{v_{BE}/V_T}$

thermal voltage= 25 mv

Current Flow in *NPN Transistor*



The Base Current: $i_B = \left(\frac{I_S}{\beta}\right) e^{v_{BE}/V} = \frac{i_C}{\beta}$

Current Flow in *NPN Transistor*

Emitter Current:

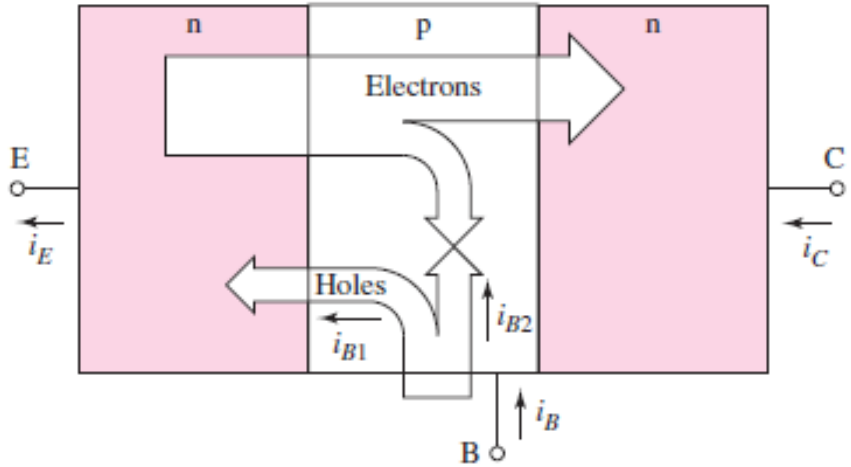
$$i_E = i_C + i_B$$

$$i_C = \beta i_B$$

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

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

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



β:Common-emitter Current Gain

α:Common-base Current Gain

Summary of Current Relations

$$i_E = i_C + i_B$$

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

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

$$i_C = \beta i_B$$

$$i_C = \alpha i_E = \left(\frac{\beta}{1+\beta}\right) i_E$$

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

Example 6.2: pp 368 , *Design*

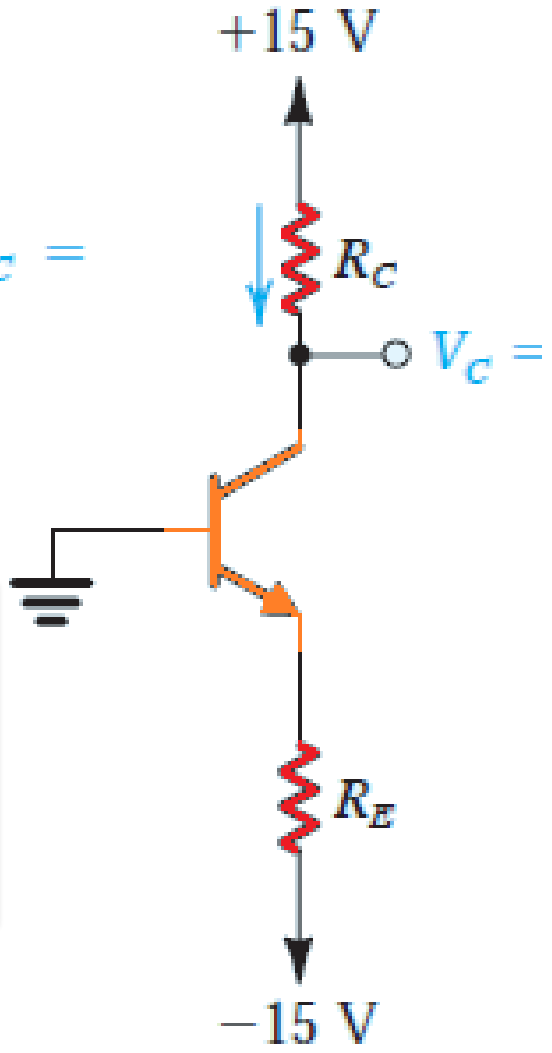
The transistor in the circuit has :

β = 100

v_{BE} of 0.7 V @ iC = 1 mA.

Ic = 2 mA.

V_C = +5 V



$$i_E = i_C + i_B \qquad i_C = \beta i_B$$

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

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

Example: *Design*

The transistor in the circuit has :

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Ic = 2 mA.

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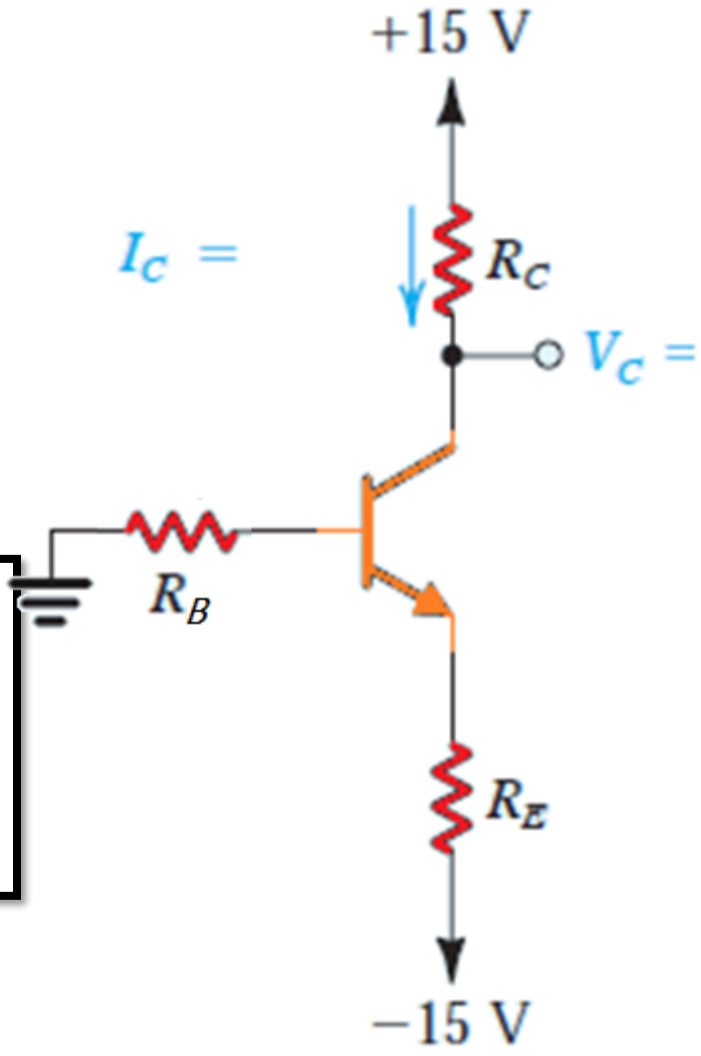


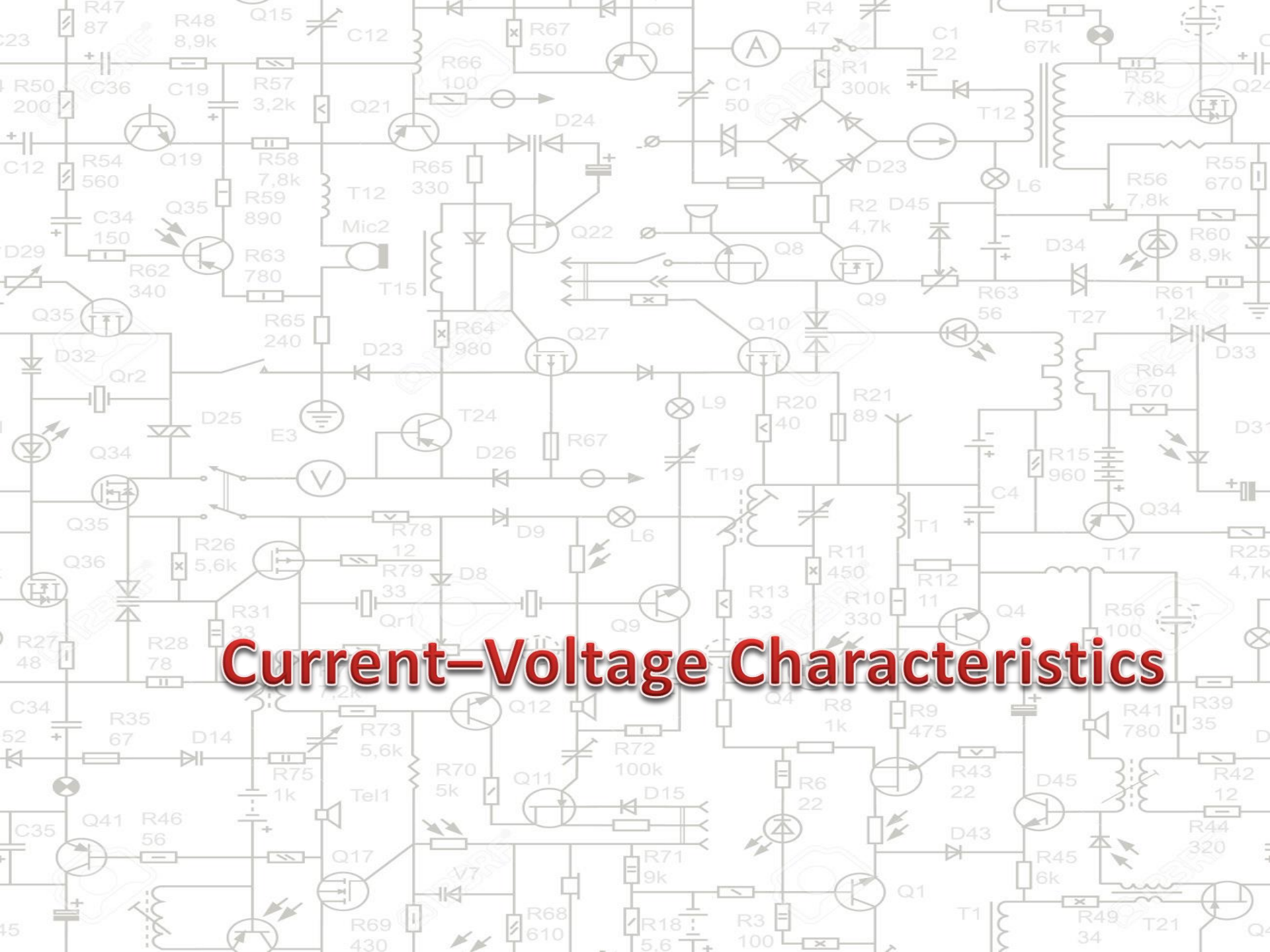
$$i_E = i_C + i_B \qquad i_C = \beta i_B$$

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

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

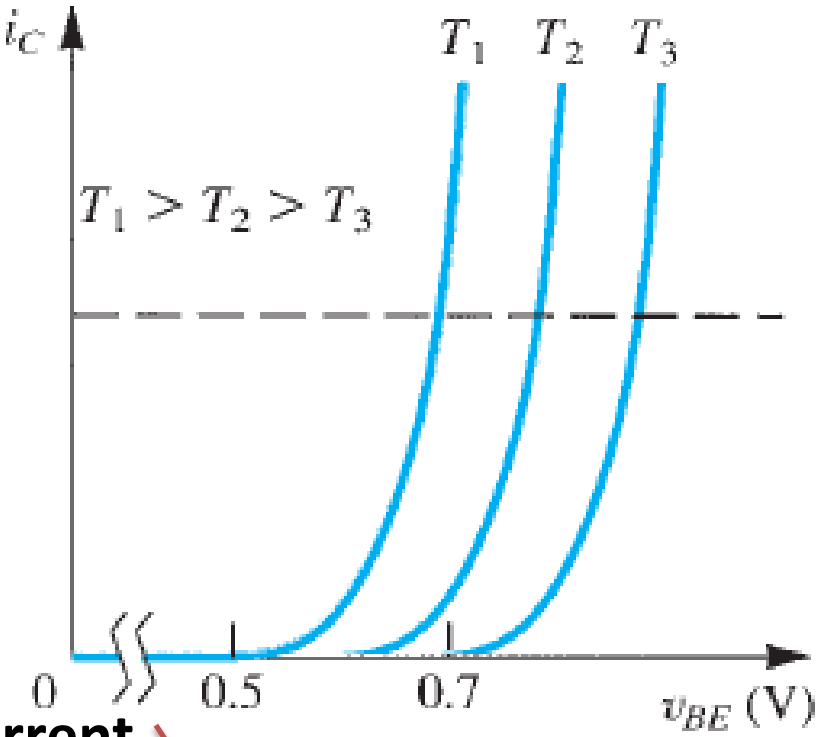
Homework

H.W : Exercise 6.13 &
Exercise 6.14 pp. 369


Current–Voltage Characteristics

i_C–v_{BE} , i_E–v_{BE} , i_B–v_{BE} characteristics

Diode



Saturation current

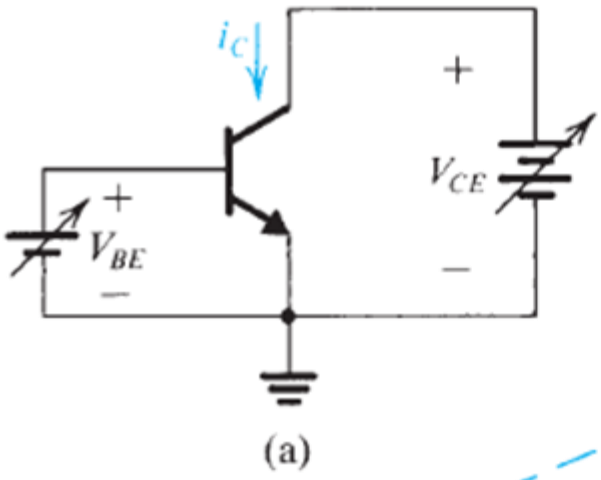
The Collector Current: $i_C = I_S e^{v_{BE}/V_T}$

thermal voltage= 25 mv

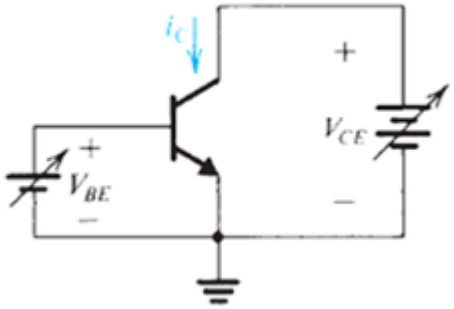
i_C–v_{CE} characteristics
Early Effect

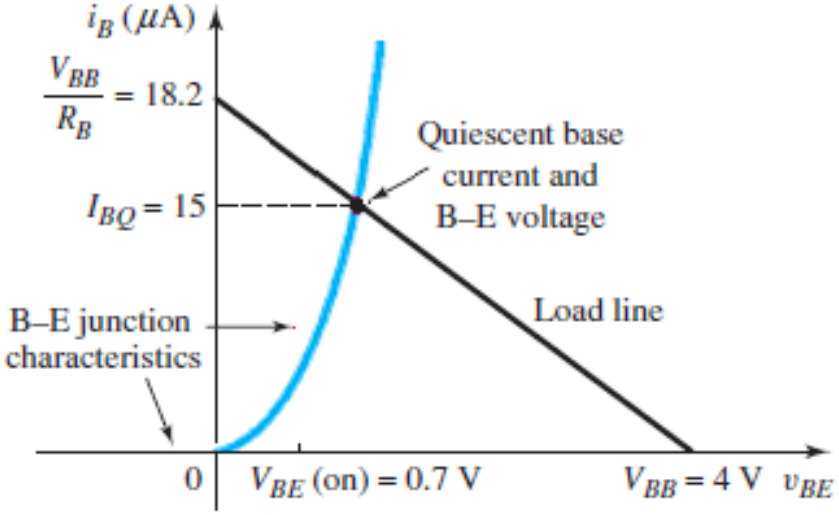
$$r_o = \frac{V_A}{I_C}$$

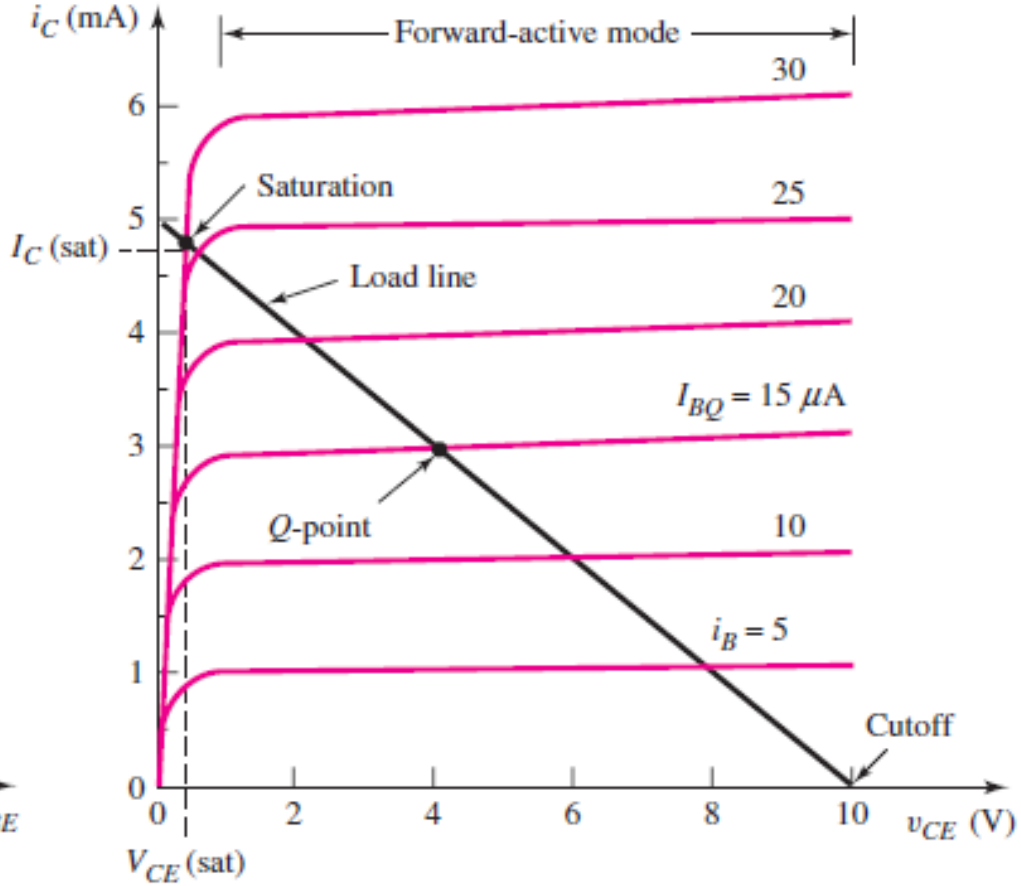
common-emitter Characteristics

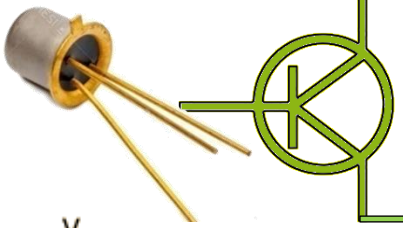


Load Line & *Q-point*





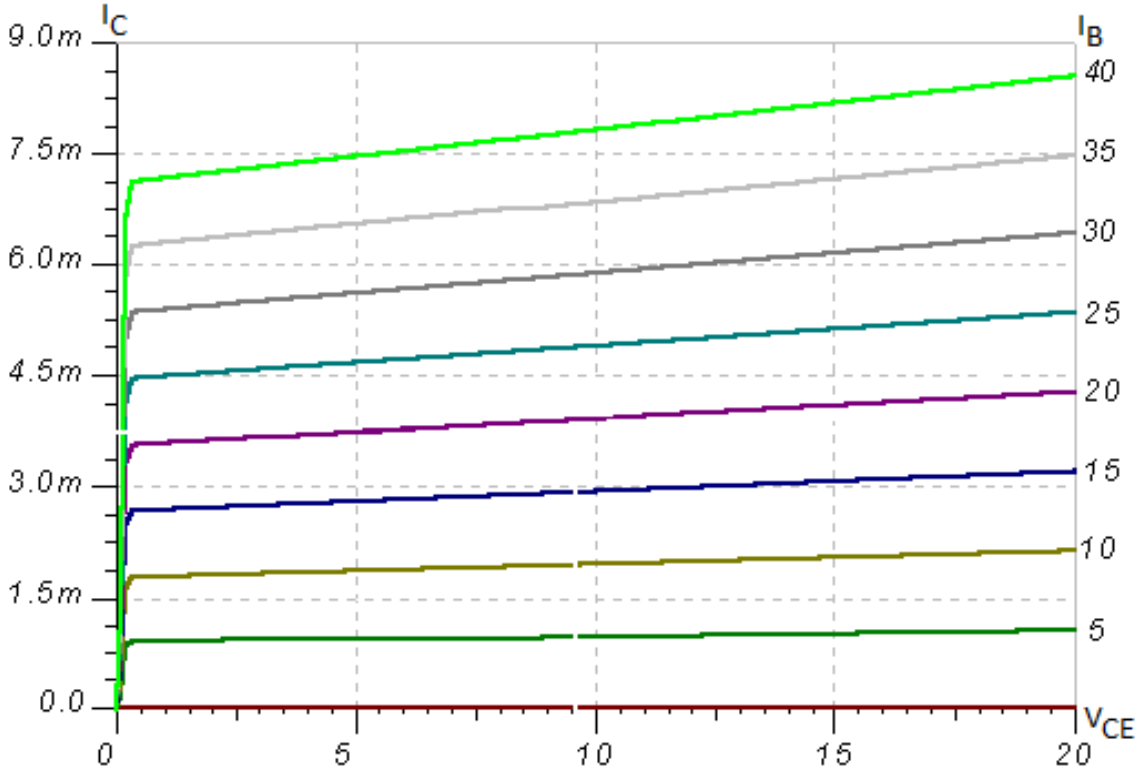


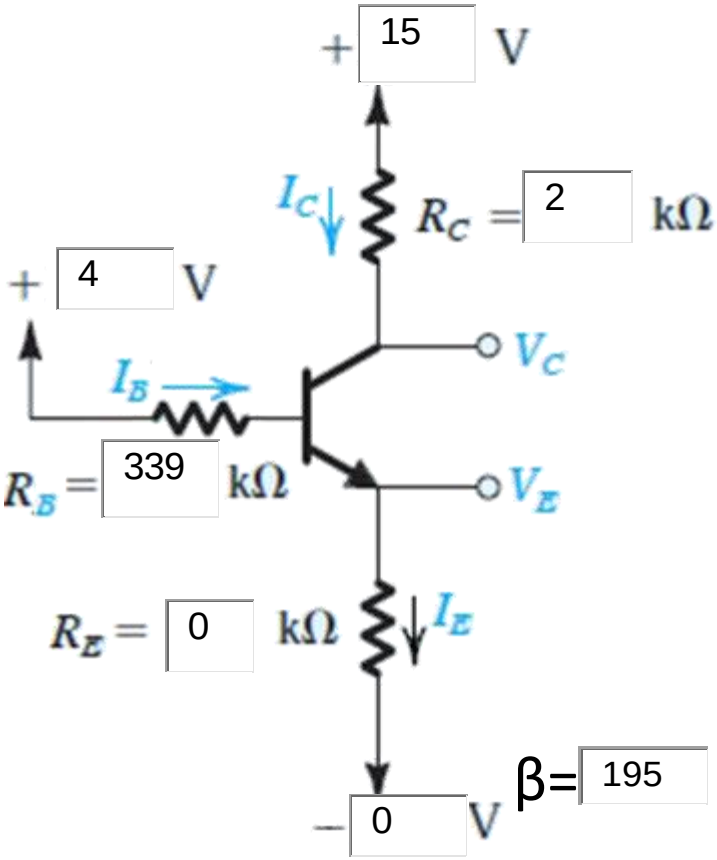


Example: by using BC107A NPN transistor (β = 195)

$\frac{V_{CC}}{R_C + R_E}$ 7.5

$$\text{Slope} = -\frac{1}{R_C}$$





I_B= 0.01 I_C= 1.95 V_{CE}= 11.1

Example: by using BC107A NPN

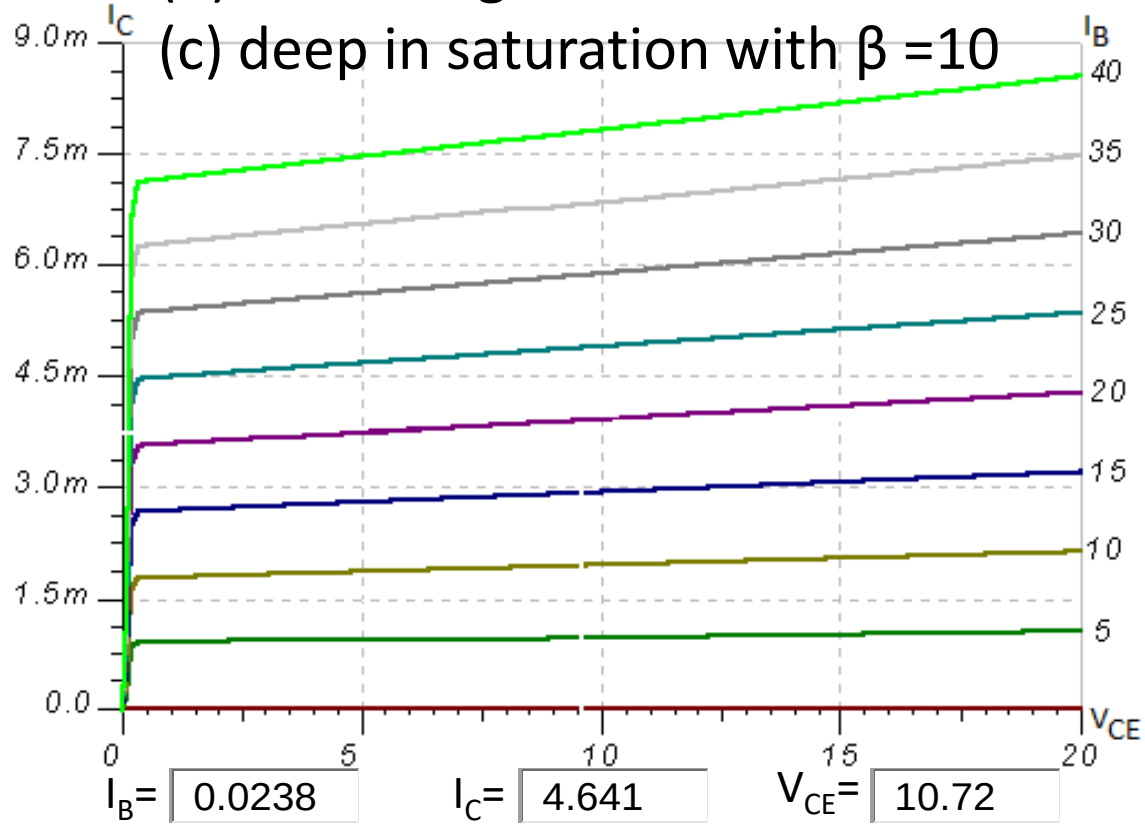
$\frac{V_{CC}}{R_C + R_E}$ 5

Design an amplifier to allocate Q point at the center with following specs VBB=VCC=20 v

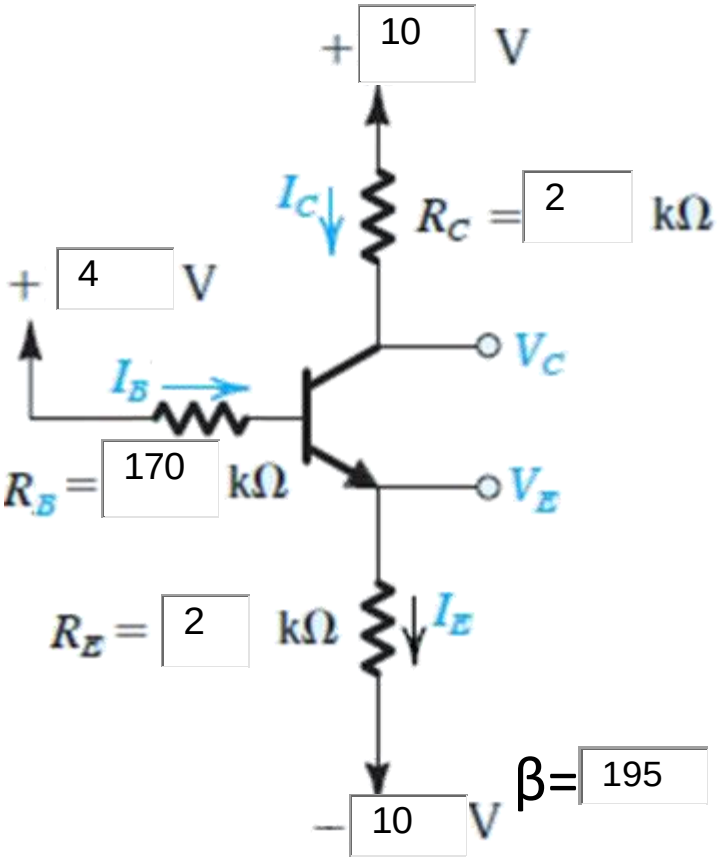
(a) in the active mode with *VCE* = 5

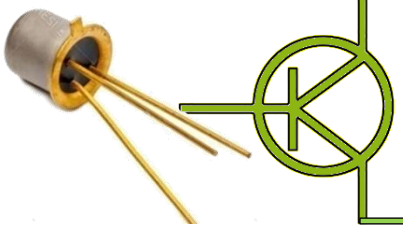
(b) at the edge of saturation

(c) deep in saturation with β =10

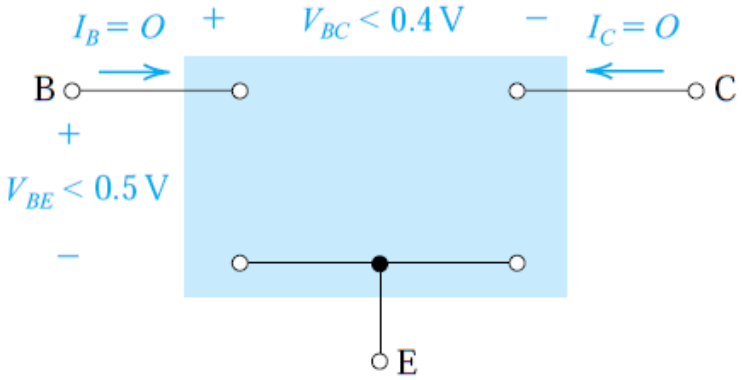


I_B= 0.0238 I_C= 4.641 V_{CE}= 10.72

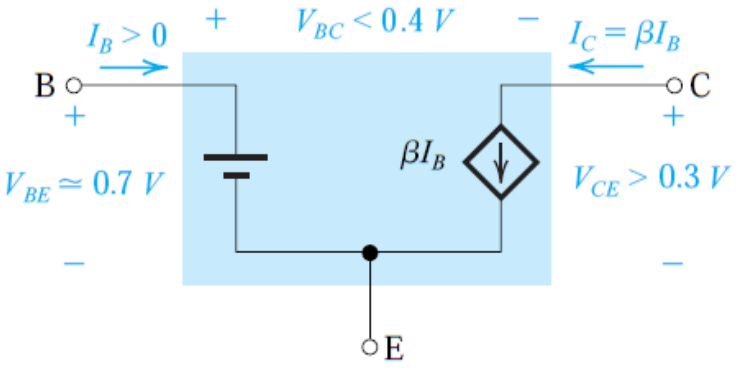




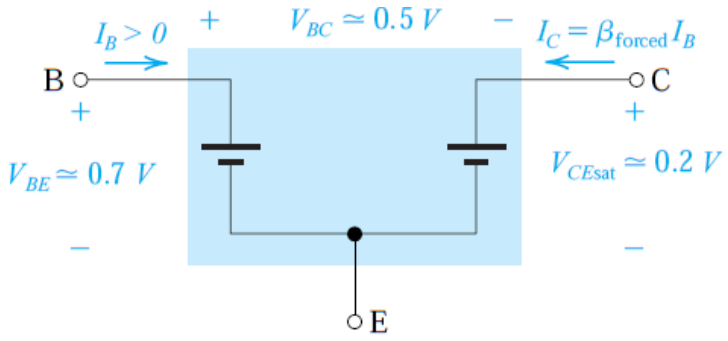
Conditions of the BJT in Various Modes



Cut off



Active



Saturation