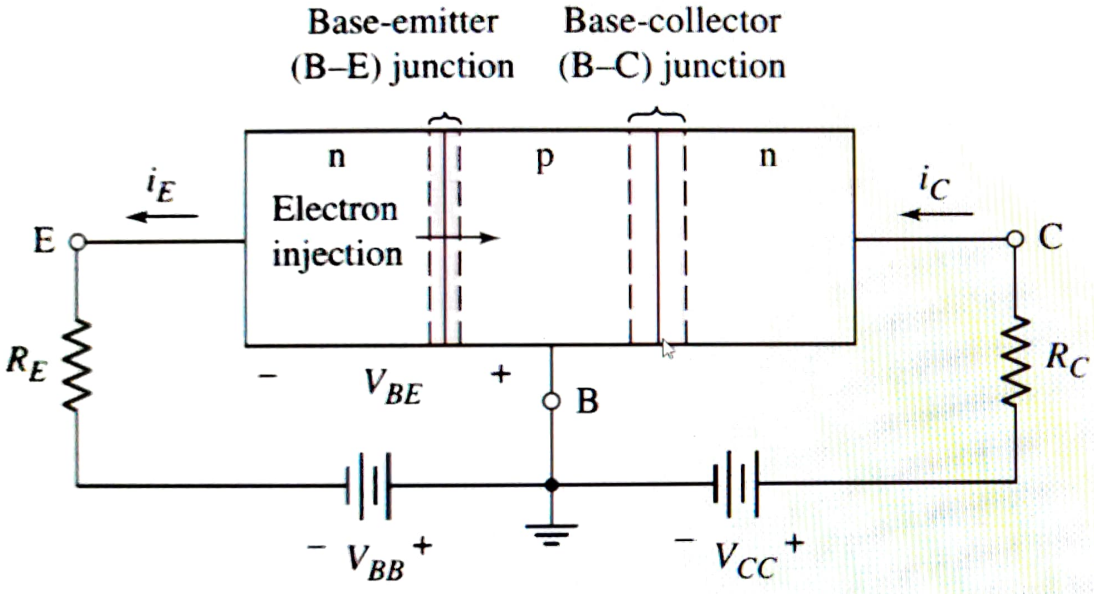
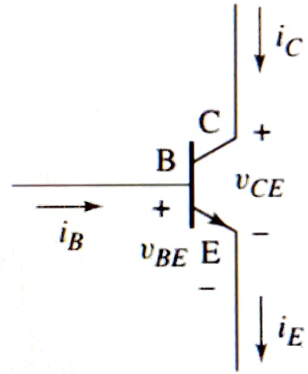
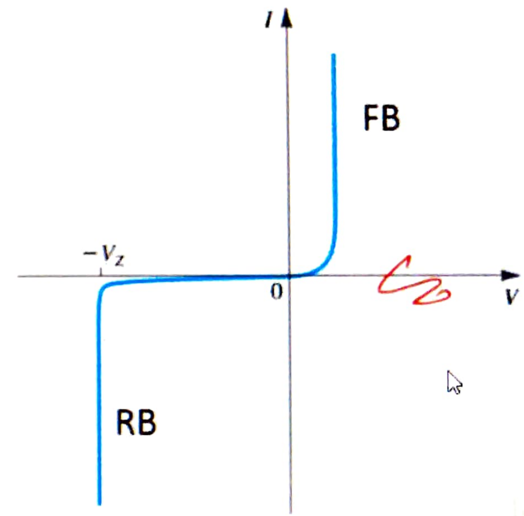
Transistor as an amplifier

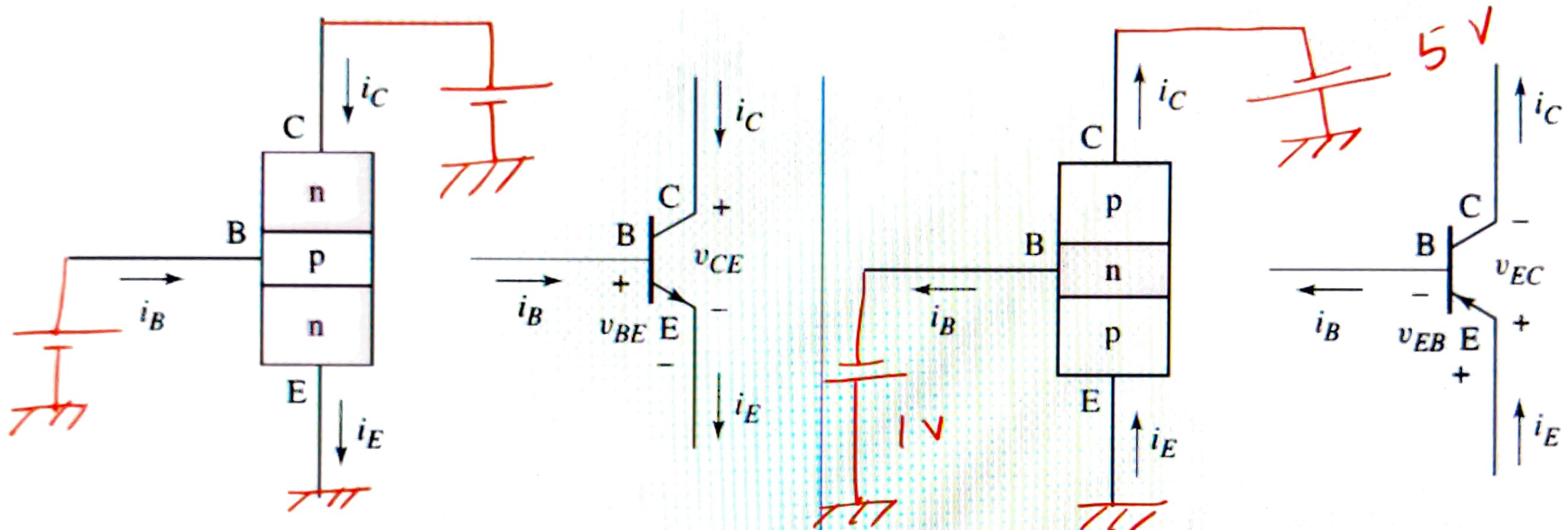






Current flow in a *npn* transistor biased to operate in the active mode

Block diagrams and circuit symbols for BJT



NPN transistor **PNP transistor**

majority – electrons holes

mobility $\mu_n > \mu_p$

Currents in BJT

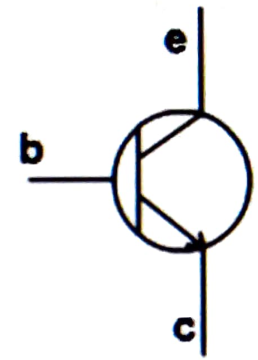
- The total current flowing into the transistor must be equal to the total current flowing out of it
- the emitter current I_E is equal to the sum of the collector (I_C) and base current (I_B)
- $I_E = I_C + I_B$
- $I_C = \alpha I_E$
- $I_C = \beta I_B$
- α = Common base current gain $\simeq 1 = 0.9996$
- β = Common emitter current gain — 50–200

$I_C = \beta I_B$

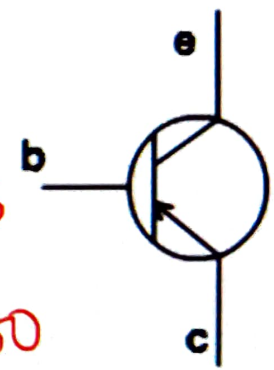
$$I_C = I_S e^{V_{BE}/V_T}$$

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

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



npn



pnp

Problem

Objective: Calculate the collector and emitter currents, given the base current and current gain.

Assume a common-emitter current gain of $\beta = 150$ and a base current of $i_B = 15\ \mu A$. Also assume that the transistor is biased in the forward-active mode.

Solution: The relation between collector and base currents gives

$$i_C = \beta i_B = (150)(15\ \mu A) \Rightarrow 2.25\ mA$$

and the relation between emitter and base currents yields

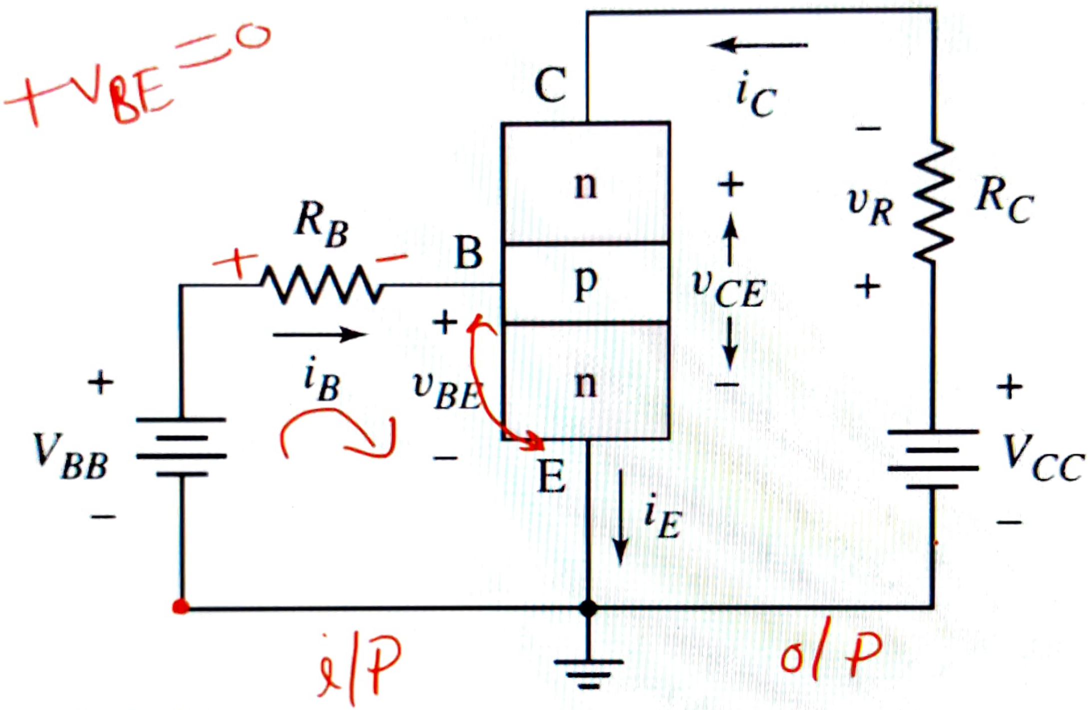
$$i_E = (1+\beta) i_B = (151)(15\ \mu A) \Rightarrow 2.27\ mA$$

the common-base current gain is

$$\alpha = \frac{\beta}{1+\beta} = \frac{150}{151} = 0.9934$$

Common emitter amplifier circuit

$-V_{BB} + i_B R_B + V_{BE} = 0$

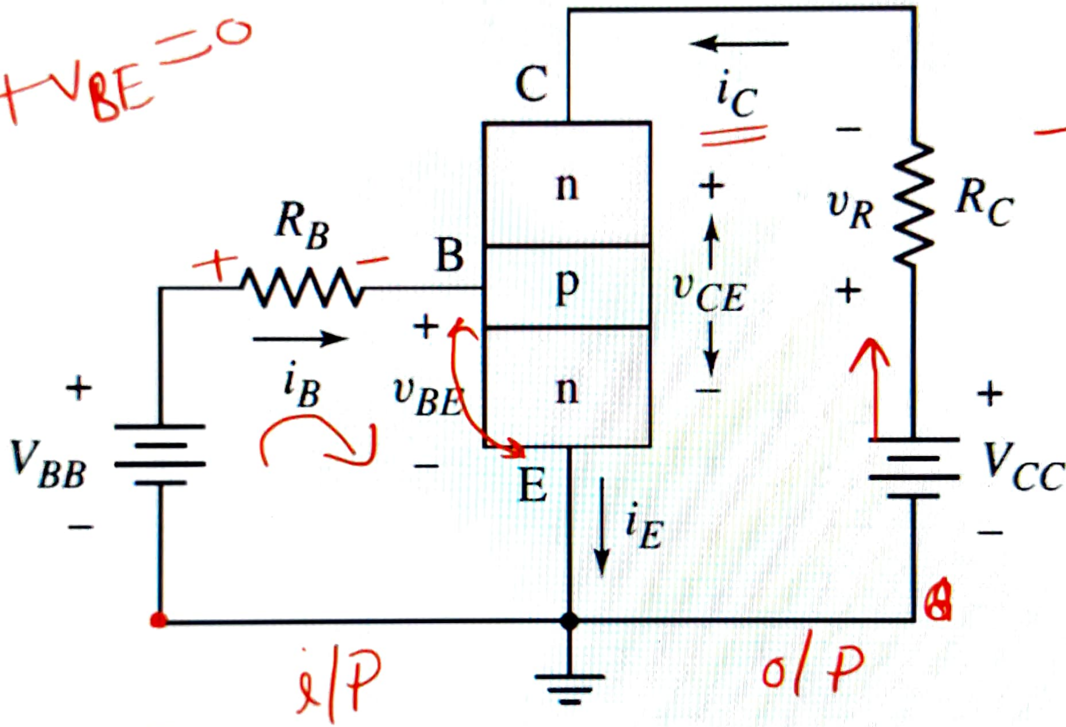


KVL?

Common emitter amplifier circuit

$-V_{BB} + i_B R_B + V_{BE} = 0$

$-V_{cc} + R_c i_c + V_{CE} = 0$



KVL?

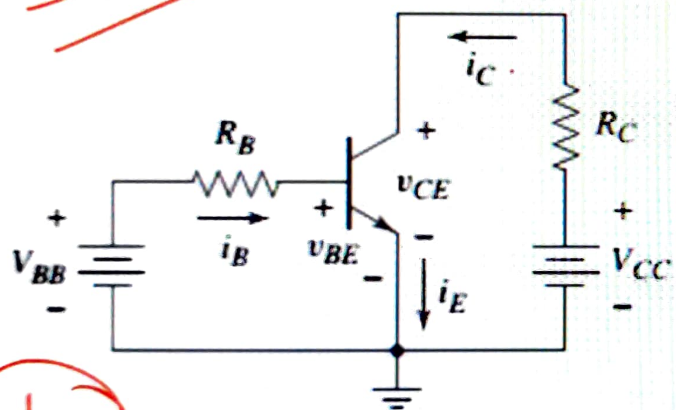
Common emitter circuits

$V_{BE} = 0.7\,V$

$V_{EB} = -0.7V$

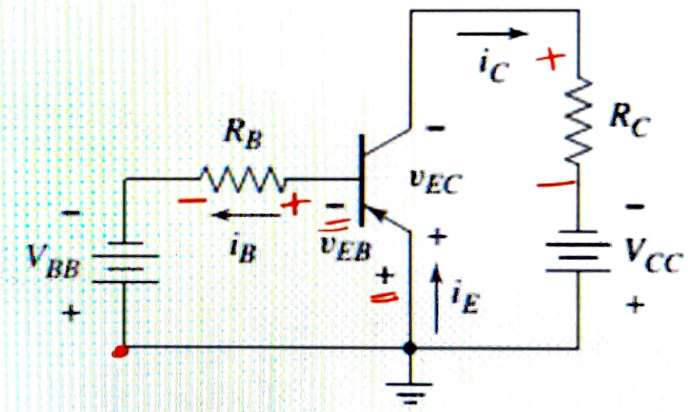
$V_{BE} = V_B - V_E = -(V_E - V_B)$

$= -V_{EB}$



V_{BE}

NPN transistor



PNP transistor

$V_{BB} - i_B R_B - V_{EB} = 0$

Input and output characteristics of BJT

FW

V=IR

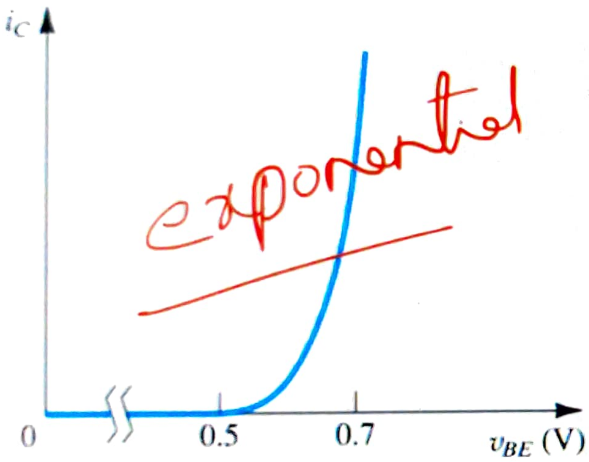
y=mx

linear

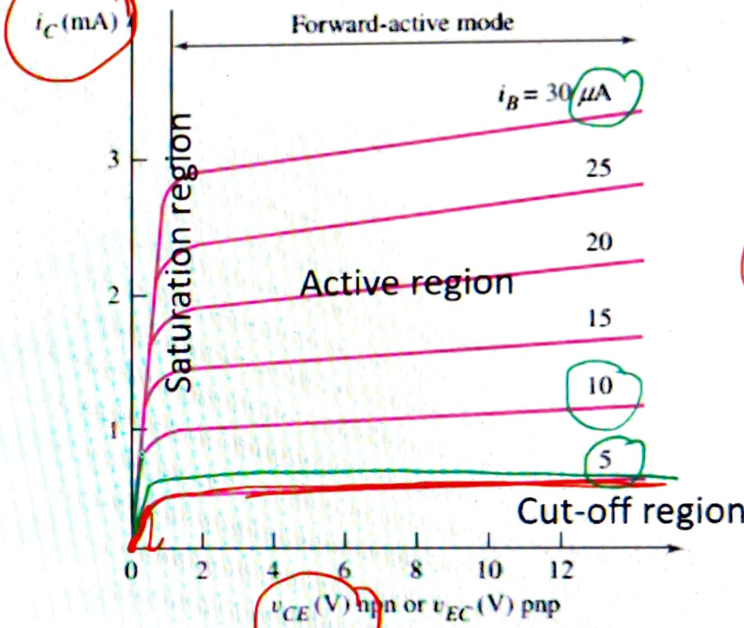
E B C

FB

PN



I/P



O/P

1mA

I_C

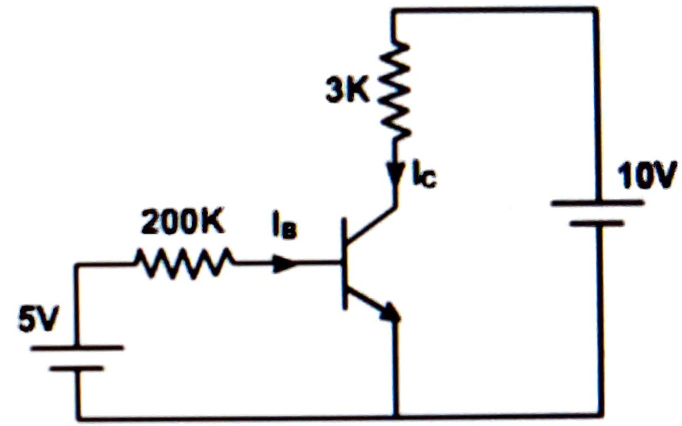
V_{CE}

5V

BE

Find the transistor currents and voltages in the circuit shown in fig. if I_{CO}= 20nA, β =100

- For the base circuit, 5 = 200 x I_B + 0.7
- Therefore, $I_B = \frac{5-0.7}{200k} = 0.0215\,\text{mA}$
- Since $I_{CO} << I_B$, therefore, $I_C = \beta I_B = 2.15$ mA
- From the collector circuit, V_{CE} = 10 - 3 x 2.15 = 3.55 V
- Since, $V_{CE} = V_{CB} + V_{BE}$
- Thus, V_{CB} = 3.55 - 0.7 = 2.85 V



Find the transistor currents and voltages in the circuit shown in fig. if I_{CO}= 20nA, β =100

$-10 + (3K) I_C + V_{CE} = 0$

$V_{CE} =$

- For the base circuit, 5 = 200 x I_B + 0.7
- Therefore, $I_B = \frac{5-0.7}{200k} = 0.0215\,\text{mA}$
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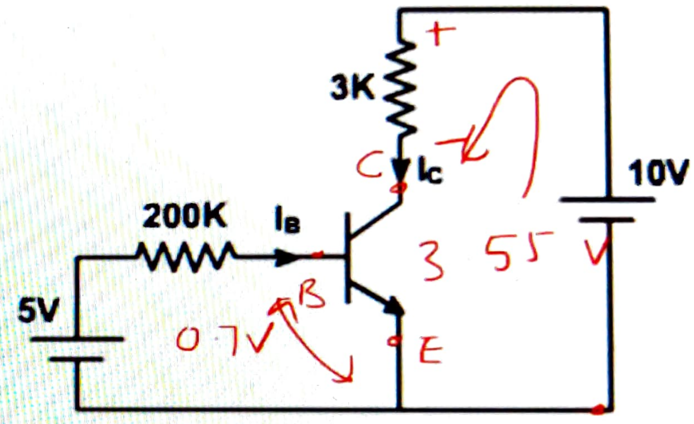
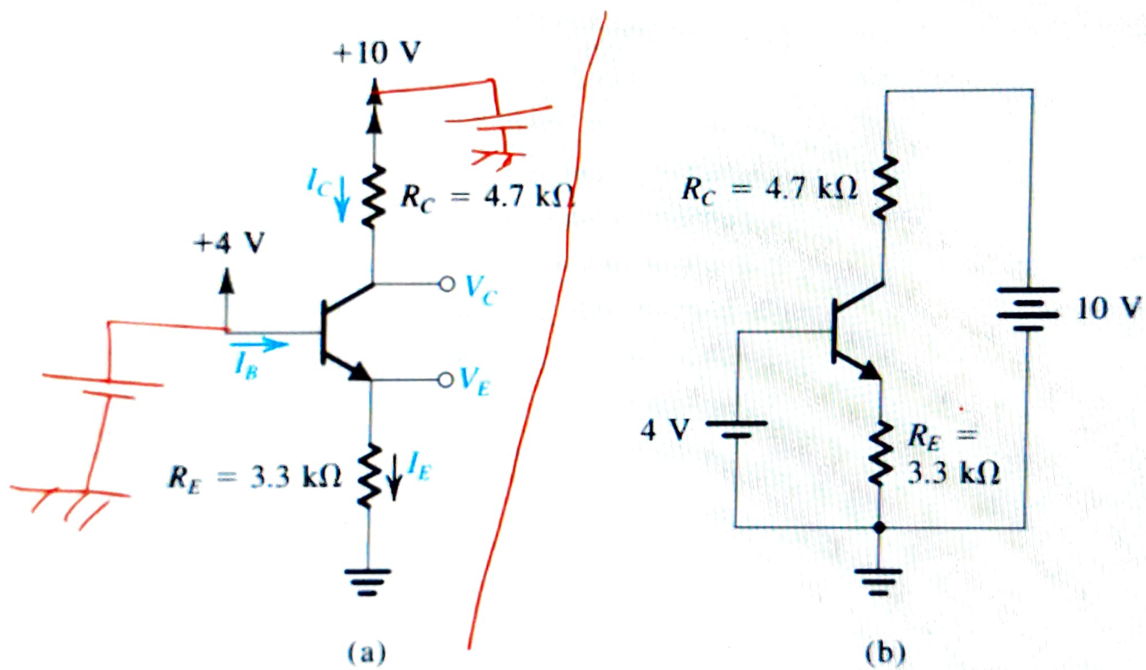


$V_{CE} = V_{CB} + V_{BE}$

β = 100



ails ^

Raise hand

Turn on captions

Paul Braine
is present