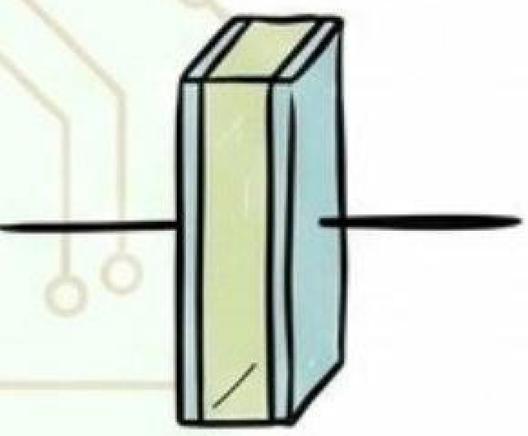
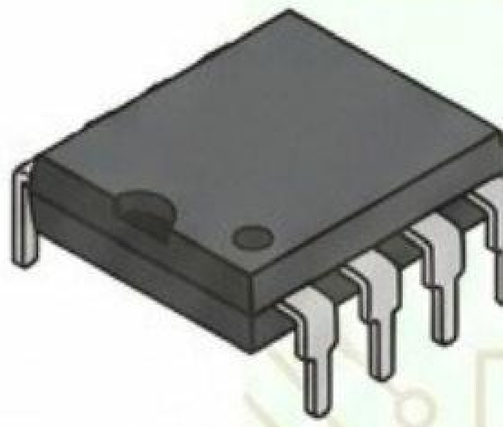
$$V = I * R$$



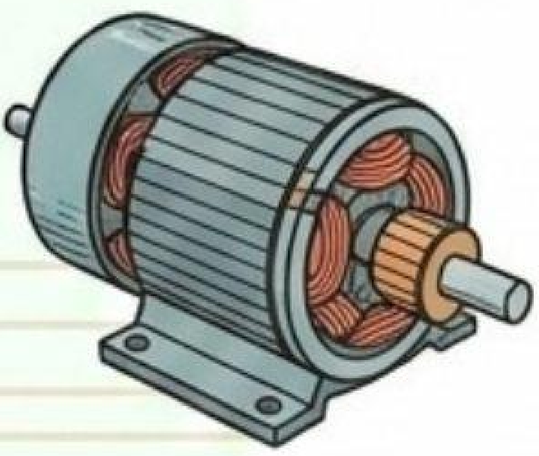
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** EE 312 **







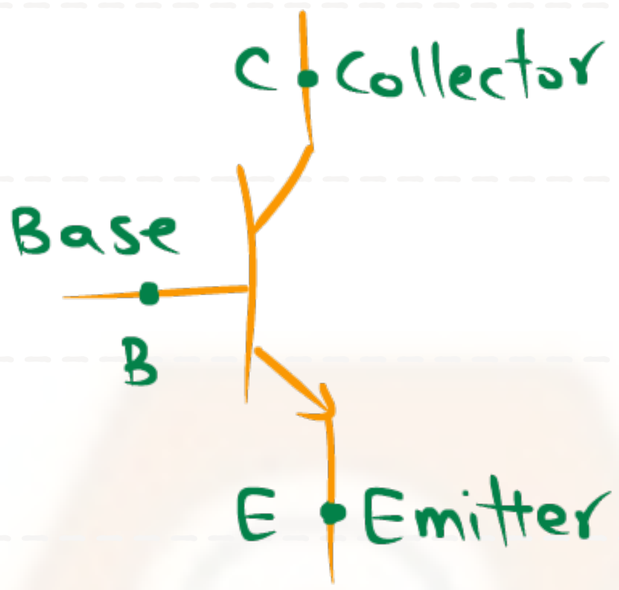


$$P = V * I * \cos(\varphi)$$

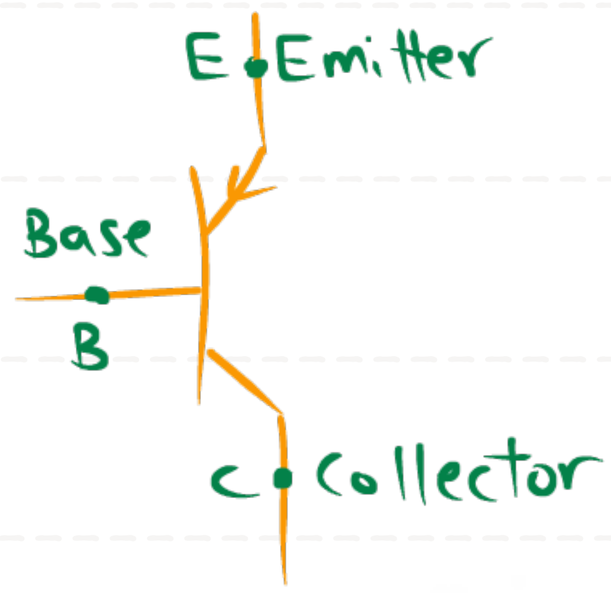
Chapter 1 — Part A

BJT ⟶ Bipolar Junction Transistor

NPN

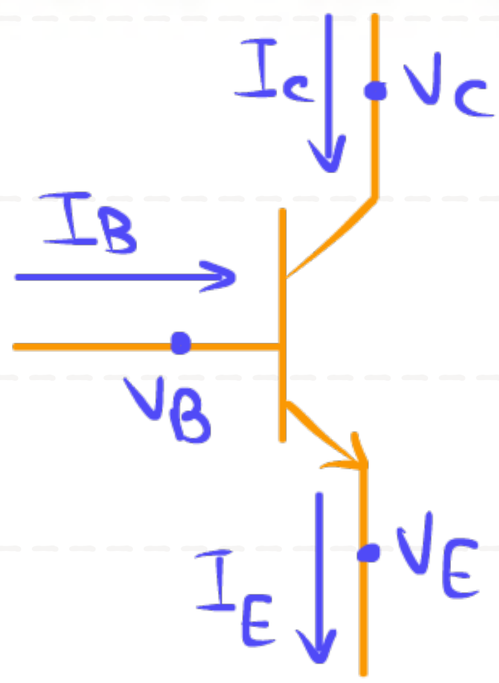


PNP



Current (I)

Voltage (V)

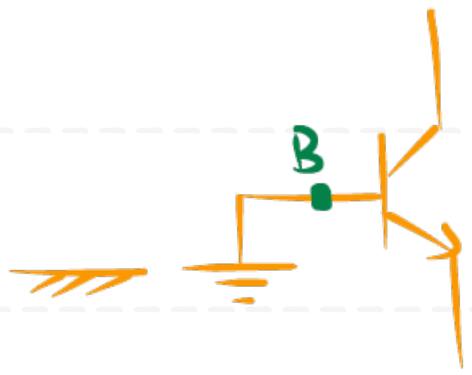


$$I_E = I_C + I_B$$

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* BJT operation *

① cutoff



off switch

② Active mode (Linear) (Active Region):

$V_{CE} \geq 0.7\,V$

Amplifier

③ Saturation

$V_{CE} \leq 0.3\,V$

Edge Deep

ON switch

$V_{CE} = 0.3V$ $V_{CE} = 0.2V$

حفظ

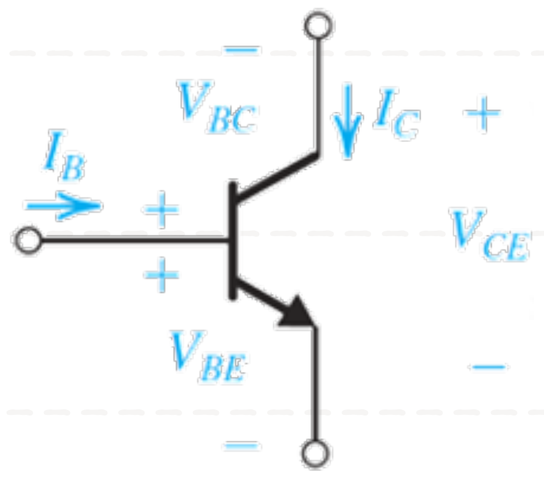
$V_{BE} = 0.7V$

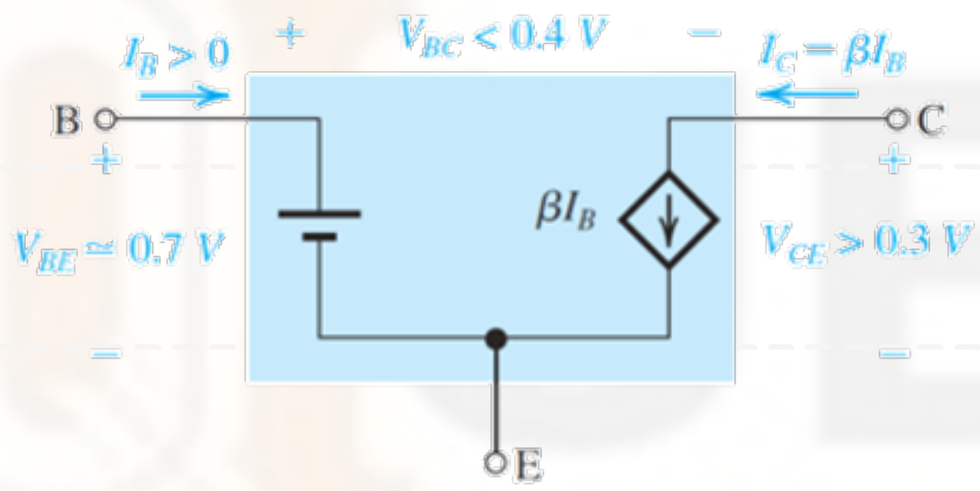
حفظ

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1. Collector to emitter voltage (if emitter is grounded) $V_{CE}=V_{CC}-I_CR_C$
2. Collector to emitter voltage (if emitter is not grounded) $V_{CE}=V_C-V_E$
3. Base to emitter voltage $V_{BE}=V_B-V_E$

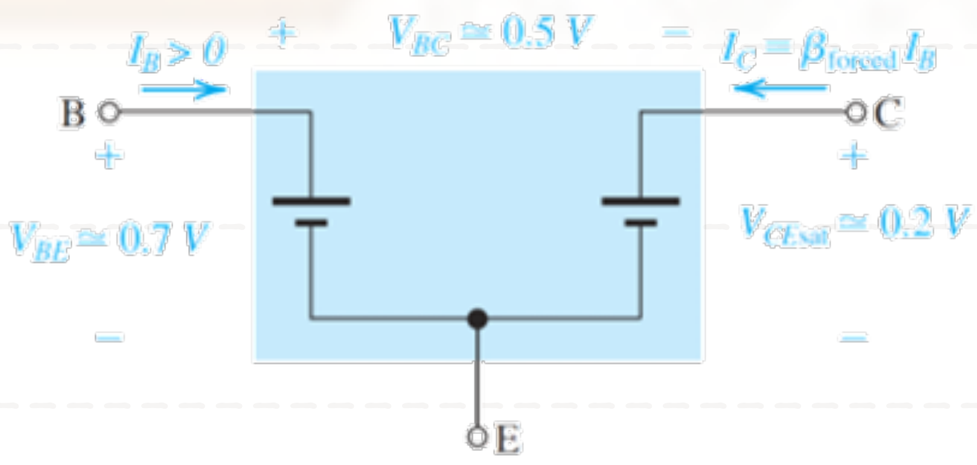
4. DC Collector current $I_C=\beta I_B=\alpha I_E$ $i_C = I_S e^{v_{BE}/V_T}\left(1+\frac{v_{CE}}{V_A}\right)$ =
5. DC Emitter current $I_E=I_C/\alpha=$ I_B+I_C
6. DC Base current $I_B = I_C/\beta + 1$
7. Common emitter gain $(\beta) = \alpha/1-\alpha$
8. Common base gain $(\alpha) = \beta/1+\beta$
9. Ohm's Law: $I = V/R$
10. Output resistance $r_o= V_A/I_C$
11. $V_{BE}= 0.7$ V for Silicon transistors (if its not given)
12. Thermal voltage $V_T= 25$ mV at room temperature (27° C)
13. Transistor operating conditions:
    a. Active Region = $V_{CE}\geq V_{BE}$





$I_E = (\beta+1) I_B$

    b. Edge of saturation = $V_{CE} = 0.3$ V



$$\beta_{forced} = \frac{i_C}{i_B}\Big|_{saturation} \leq \beta$$

    c. Deep saturation = $V_{CE} = 0.2$ V,
14. Gain (Av) = $-(V_{CC}-V_{CE}/V_T)$ (maximum gain in the linear region)
15. The formula for computing difference in voltage in V_{BE} is

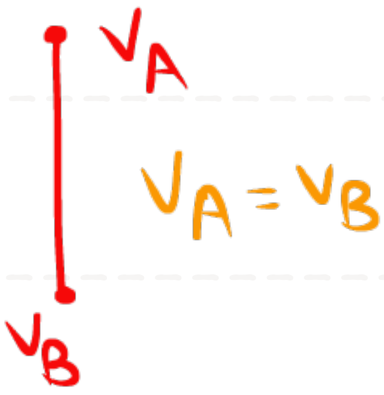
$$\Delta v_{BE} = V_T \ln\left(\frac{I_{C2}}{I_{C1}}\right)$$

Sample Problem 2

- Analyze the given NPN transistor circuit (Figure 2) with different value of R_B to identify the state of operation. V_{cc}= 12 V, R_C = 650 Ohm, R_B = 200 KΩ, 400 KΩ and 10 KΩ. Also, identify the value of R_B at which the transistor still works in Active region. Let, β = 100

I_C , I_B, I_E

V_C, V_B, V_E



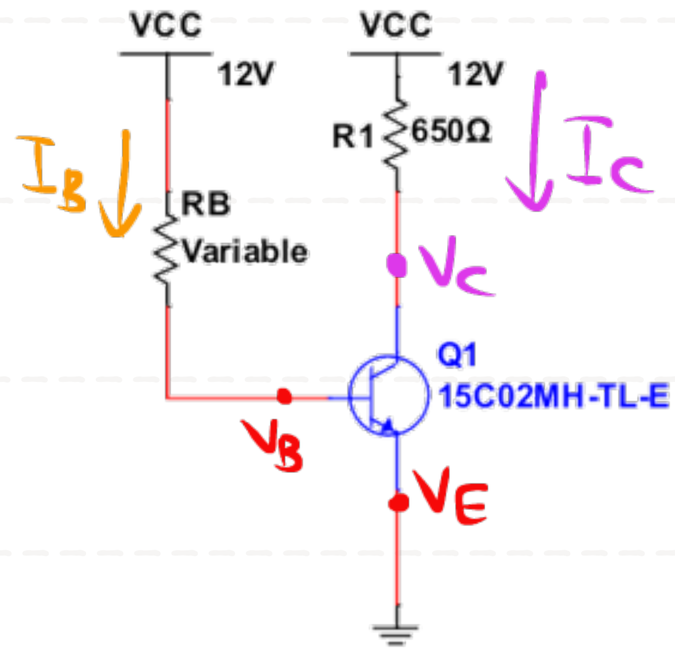


Figure 2

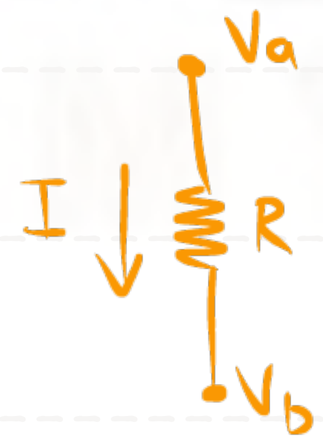
* R_B = 200 kΩ

$V_E = 0\ V$

$\therefore V_{BE} = V_B - V_E \longrightarrow V_{BE} = V_B - 0$

$\therefore V_{BE} = V_B = 0.7\ V$

$\therefore V_B = 0.7\ V$



$\therefore I_B = V_{cc}/R_B = \dfrac{12}{200 \times 10^3}$

$I_B = 60\ \mu A$

$I = \dfrac{V_a - V_b}{R}$

$\therefore I_C = \beta I_B = 100 \times 60 \times 10^{-6}$

$\therefore I_C = 6\ mA$

$\therefore I_E = (\beta + 1) I_B = (100 + 1) \times 60 \times 10^{-6}$

$\therefore I_E = 6.06\ mA$

m ⟶ $\times 10^{-3}$

μ ⟶ $\times 10^{-6}$

k ⟶ $\times 10^{3}$

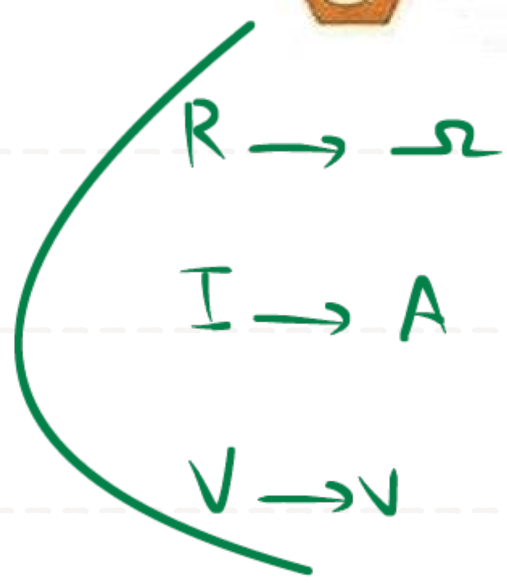
$\therefore V_C = V_{CC} - R_1 I_C$

$= 12 - 650 \times 6 \times 10^{-3}$

$\therefore V_C = 8.1\ V$

$\therefore V_{CE} = 8.1\ V \geq 0.7\ V$

B_JT is in Active Region



* $R_B = 400\ k\Omega$

نفس الطريقه السابقه

B_JT is in Active Region

* $R_B = 10\ k\Omega$

سوى نفس الخطوات

$I_B = 1.2\ mA$

$I_C = 120\ mA$

$V_C = -66\ V$

$V_{CE} = V_C - \cancel{V_E}^{=0}$

$V_{CE} = -66\ V \leq 0.3\ V$

B_JT is in saturation

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* $R_B = ?$ Which transistor still in Active

$$I_{C(max)} = \frac{V_{CC}}{R_C} = \frac{12}{650} = 18.46 \text{ mA}$$

$$I_{B(max)} = \frac{I_{C(max)}}{\beta} = \frac{18.46 \times 10^{-3}}{100} = 0.0001846$$

$$I_{B(max)} = \frac{V_{CC}}{R_B}$$

$$R_B = \frac{V_{CC}}{I_{B(max)}} = \frac{12}{0.0001846}$$

$\therefore R_B = 65 \text{ k}\Omega$

#

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