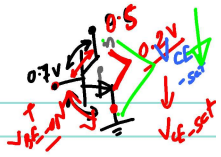
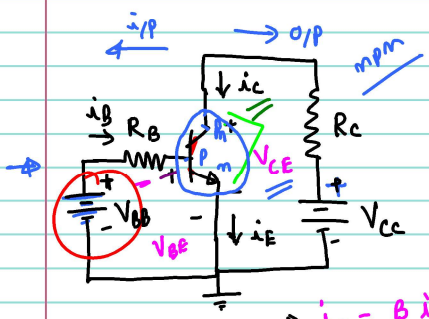
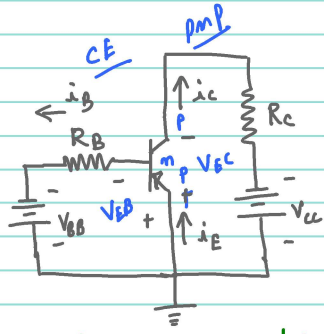
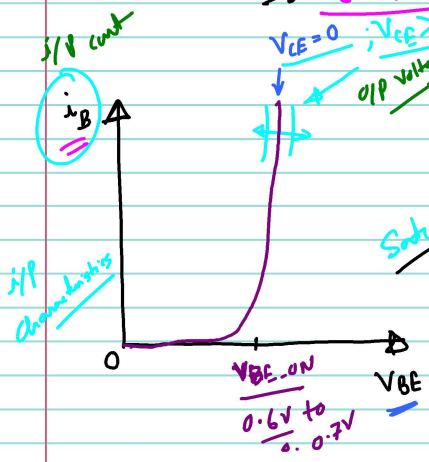
Common Emitter circuit (CE):

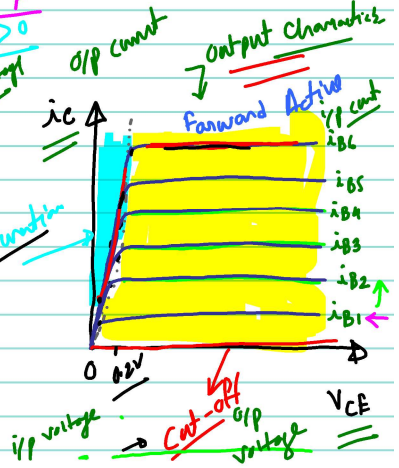






$i_C = \beta i_B$





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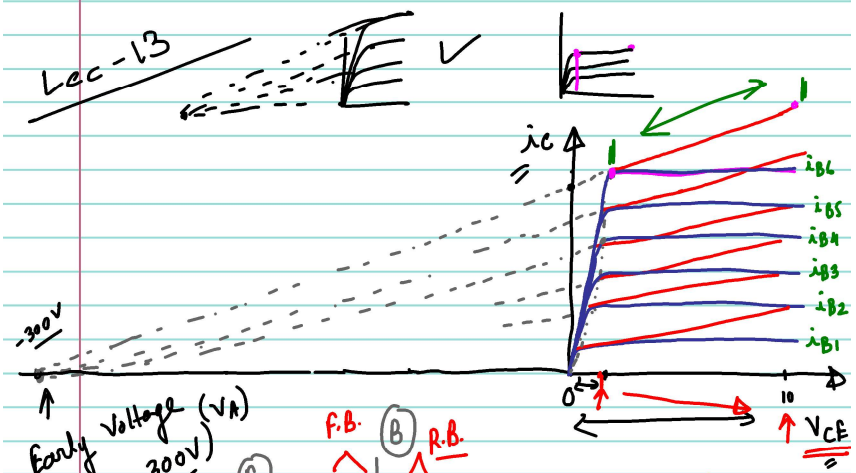
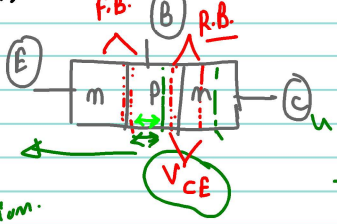


Early Voltage (V_A) (50 - 300V)



Base width modulation.

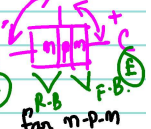
J.M. Early

Early Effect

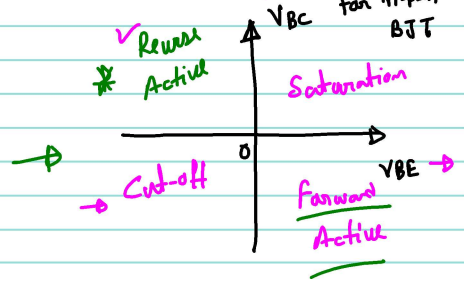
Active region $\rightarrow$ $i_C = \left[I_S \exp\left(\frac{V_{BE}}{V_T}\right)\right]\left(1 + \frac{V_{CE}}{V_A}\right)$

$\frac{1}{r_o} = \left.\frac{\partial i_C}{\partial V_{CE}}\right|_{V_{BE}=\text{const.}} = \frac{\left[I_S \exp\left(\frac{V_{BE}}{V_T}\right)\right]}{V_A} = \frac{I_C}{V_A}$

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



for n-p-n BJT



So, BJT is in Saturation [$i_c \neq \beta i_B$] ×

$V_{CE\text{-}sat} = 0.2V$. , KVL in outer loop,

$\beta = 100$

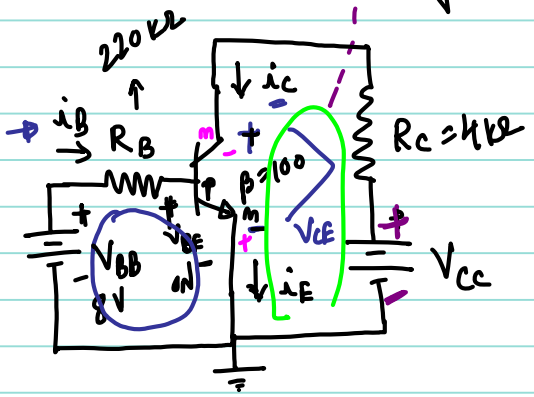
$i_C = \frac{V_{CC} - V_{CE(sat)}}{R_C} = \frac{10 - 0.2}{4}$

$= 2.45$ mA.

C.E. Curr gain $= \frac{i_C}{i_B} = \frac{2.45\text{ mA}}{33.2\,\mu A}$

≈ 74

BJT Circuit : DC Analysis



Given that,

$V_{CC} = 10\,V$, $R_C = 4k\Omega$

$V_{BB} = 8\,V$, $R_B = 220k\Omega$

$\beta = 100$

$i_B = \frac{8 - 0.7}{220k\Omega} = 33.2\,\mu A$

Assuming, BJT is in Forward Active Mode

$i_C = \beta i_B$

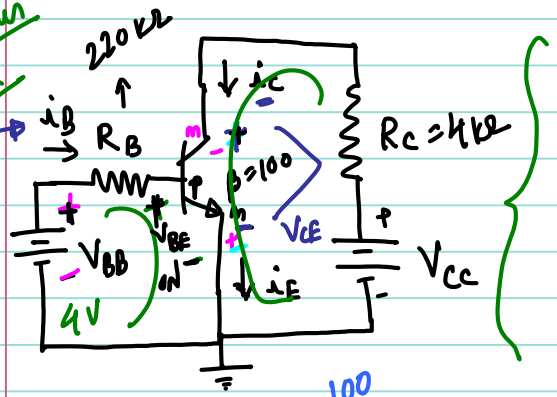
$= 100 \times 33.2\,\mu A$

$i_C = 3.32$ mA.

$V_{CE} = V_{CC} - I_C R_C = 10 - 3.32 \times 4 = -3.28\,V$. ←

Assumption was not correct.

Another case



only, V_{BB} is changed to 4V.

$i_B = \frac{4 - 0.7}{220k\Omega} = 15\,\mu A$

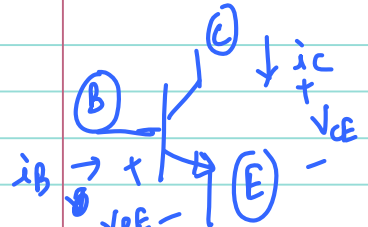
Assume, Active mode of operation

$i_c = \beta i_B = 1.5$ mA.

$\beta = 100$

→ $V_{CE} = V_{CC} - i_c R_C = 4V$

Calculate the power dissipation in the BJT



$P_T = i_B \cdot V_{BE} + i_C \times V_{CE}$

$V_{BE} = 0.7V$, $i_B = \frac{i_C}{\beta}$

$P_T = i_C \times V_{CE} = 1.5\text{ mA} \times 4\,V$

$P_T = 6$ mW

BJT DC Analysis: (n-p-n)

(i) Assume BJT is in forward active mode

→ $V_{BE} = V_{BE(ON)} \approx 0.7\,V$ for Silicon BJT

$I_B > 0$ and $I_C = \beta I_B$

(ii) Analyze the 'linear' circuit.

(iii) If $V_{CE} > V_{CE(sat)}$ → then active region (our assumption is correct)

→ if $V_{CE} < 0$ → Probably, BJT is in saturation

→ if $I_B < 0$ → Probably BJT is in Cut-off

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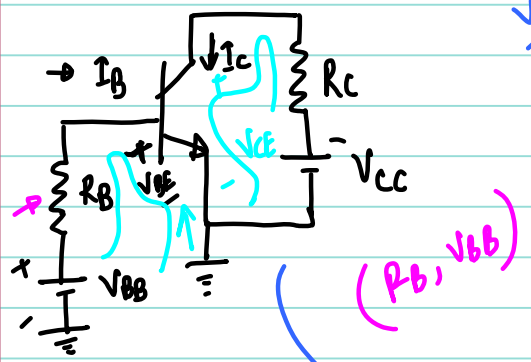
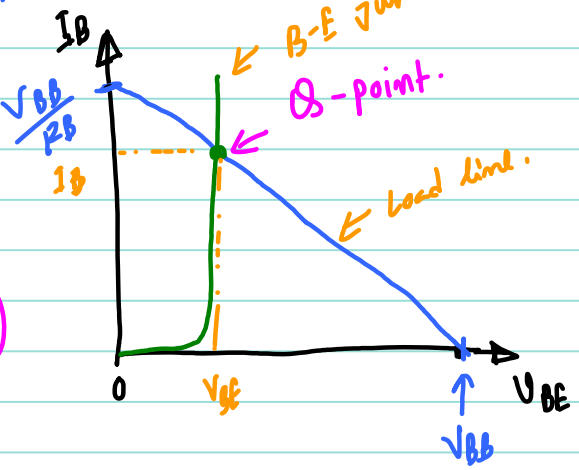
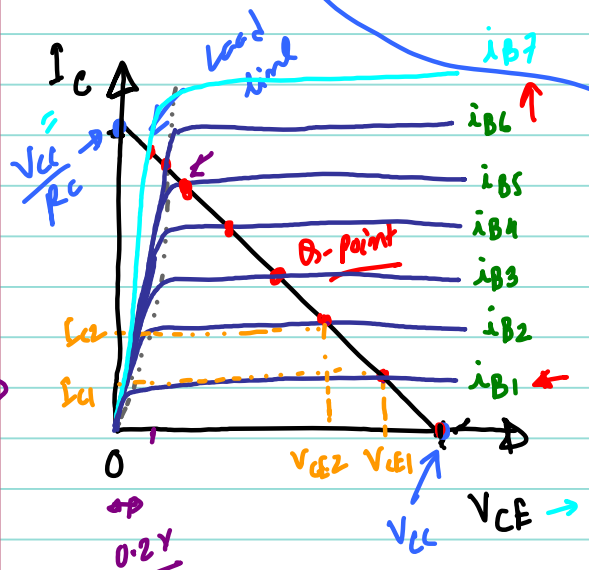
Load line:

$V_{BB} = I_B R_B + V_{BE}$, $I_B = \frac{V_{BB}}{R_B} - \frac{V_{BE}}{R_B}$





(R_B, V_{BB})



$V_{CC} = I_C R_C + V_{CE}$

$I_C = \frac{V_{CC}}{R_C} - \frac{V_{CE}}{R_C}$