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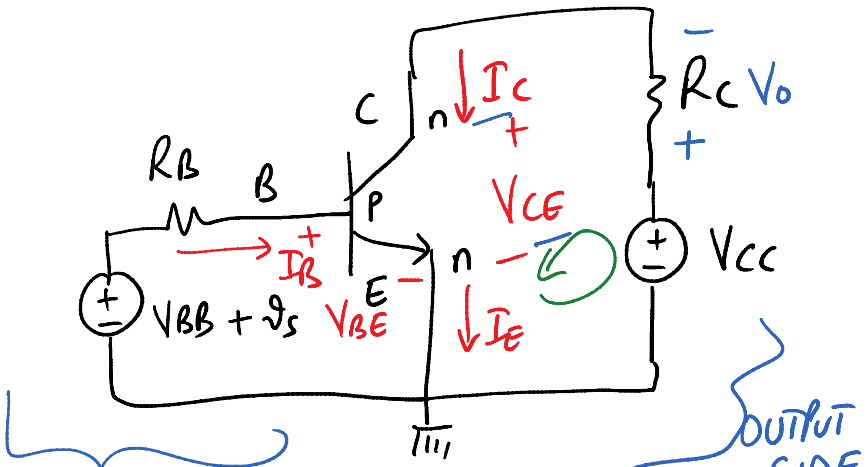
LECTURE-26

COMMON EMITTER BJT CIRCUIT

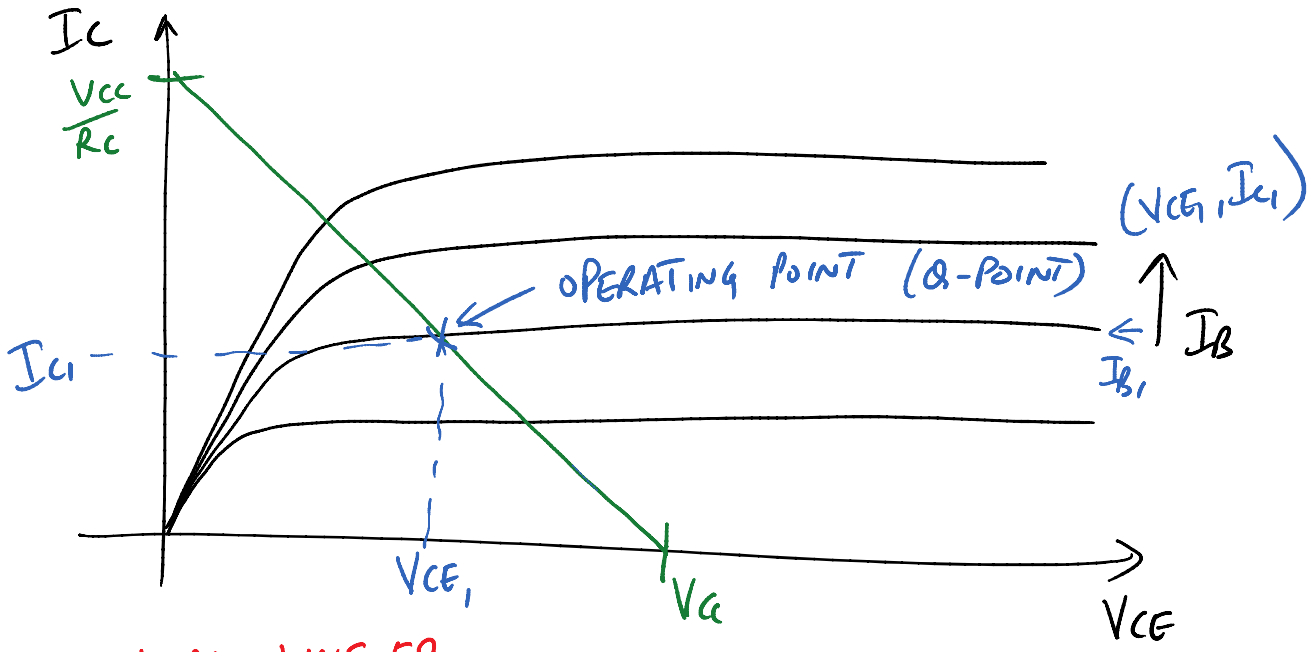


ACTIVE REGION OPERATION

BE JUNCTION IS FB $V_{BE} \geq V_{\gamma}$ (TURN-ON VOLTAGE)

CB " IS RB $V_{BC} < 0$ OR $V_{CB} > 0$

OPERATING POINT (V_{CE}, I_C



LOAD LINE EQ.

KVL CE LOOP

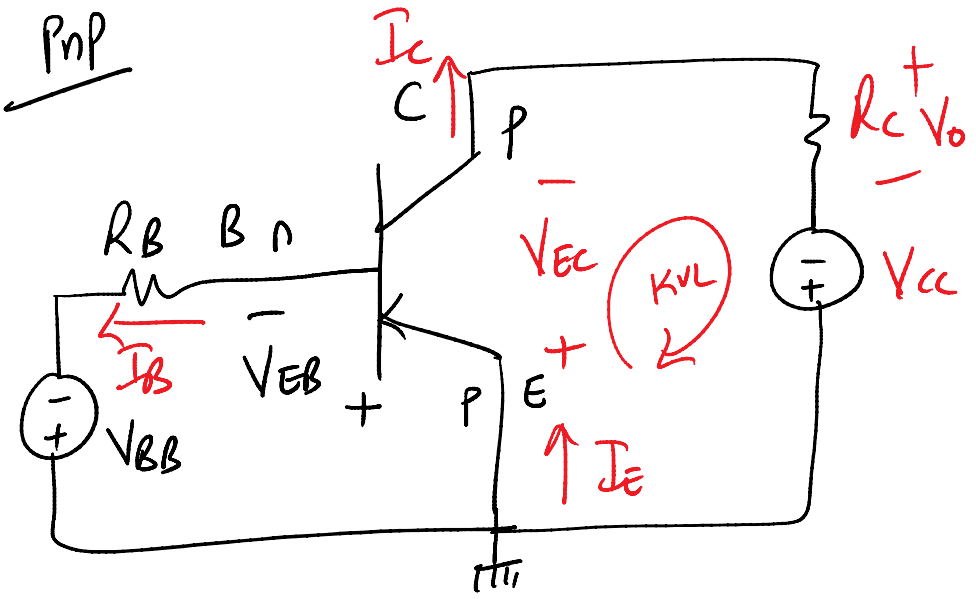
$-V_{CC} + I_C R_C + V_{CE} = 0$

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

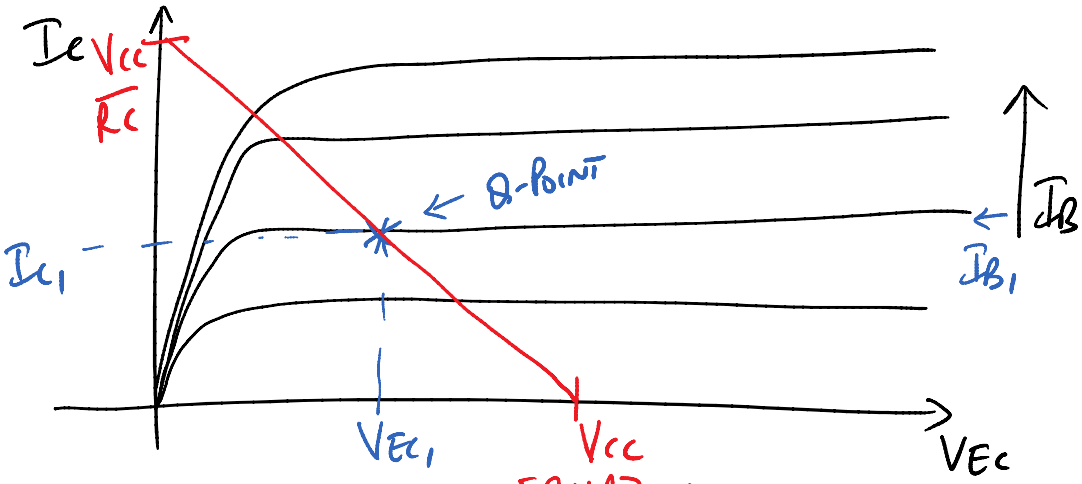
$V_{CE} = 0 \qquad I_C = \frac{V_{CC}}{R_C}$

$I_C = 0 \qquad V_{CE} = V_{CC}$

PnP



Q-POINT (VEC, Ic)



LOAD LINE EQUATION

KVL EC LOOP (OUTPUT)

$+V_{EC} + I_C R_C - V_{CC} = 0$

$V_{EC} = V_{CC} - I_C R_C$

$V_{EC} = 0 \quad I_C = \frac{V_{CC}}{R_C}$

$I_C = 0 \quad V_{EC} = V_{CC}$

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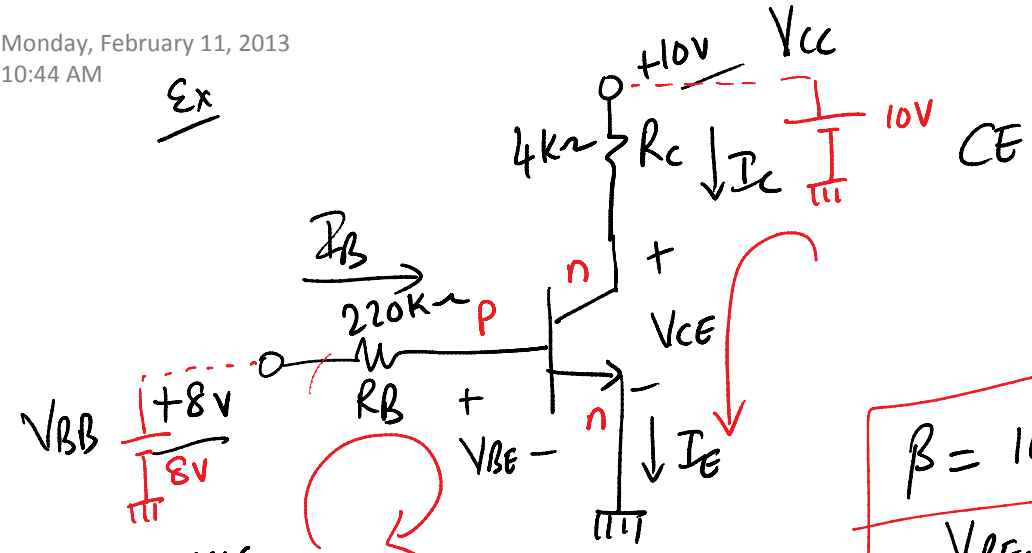
Ex



$\beta = 100$ → ACTIVE REGION!

$V_{BE(ON)} = 0.7\,V$

$V_{CE(SAT)} \leq 0.2V$

* DO NOT KNOW THE REGION OF OPERATION

ASSUME BIAS IS IN THE ACTIVE REGION

+8V ON BASE SIDE ∴ TRANSISTOR IS ON!

∵ BE JUNCTION IS FB

$V_{BB} > V_{to} = 0.7V$ ($V_{BE(ON)}$)

KVL BE LOOP

$-8 + I_B R_B + V_{BE} = 0$

$I_B = \frac{8 - 0.7}{220K} = 33.2\,\mu A$

$I_C = \beta I_B$ → ONLY VALID IF BJT IS IN ACTIVE REGION

$= 3.32\,mA$

KVL CE LOOP

$$-10 + I_C R_C + V_{CE} = 0$$

$$V_{CE} = 10 - (3.32m)(4K) = -3.28V$$

X NOT POSSIBLE!

∴ TRANSISTOR IS IN SATURATION!

RE DO THE ANALYSIS AND START FROM O/P SIDE

$$V_{CE} = V_{CE(SAT)} = 0.2V$$

KVL CE LOOP

$$I_C = I_{C(SAT)} = \frac{V_{CC} - V_{CE(SAT)}}{R_C} = \frac{10 - 0.2}{4K} = 2.45mA$$

$V_{BE} = 0.7V$

$\therefore I_B = 33.2\,\mu A$

$$\frac{I_C}{I_B} = \frac{2.45m}{33.2\mu} = 74 < \beta$$

β_{FORCED} IN SATURATION

DEEP SATURATION → V_{BB} ↑↑ I_B ↑↑ I_C SAME

$\therefore \frac{I_C}{I_B}$ ↓↓ ∴ β_{FORCED}

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$$I_E = I_B + I_C = 2.45m + 33.2\mu = 2.48mA$$

POWER DISSIPATED IN TRANSISTOR

$$P_T = I_B V_{BE(ON)} + I_C V_{CE}$$

$$= (33.2\mu)(0.7) + (2.45m)(0.2)$$

$$= \underline{\underline{0.513mW}}$$

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STEPS TO ANALYZE

1. ASSUME TRANSISTOR IS BIASED IS FORWARD ACTIVE REGION $\therefore V_{BE} = V_{BE(ON)}$, $I_B > 0$, $I_C = \beta I_B$
2. ANALYZE THE CIRCUIT
3. IF $V_{CE} > V_{CE(SAT)}$, THEN O.K
4. IF $I_B < 0 \longrightarrow$ CUT-OFF $I_B = 0$ $I_C = 0$ $V_{CE} = V_{CC}$

   IF $V_{CE} \leq V_{CE(SAT)} \longrightarrow$ SATURATION $V_{CE} = V_{CE(SAT)}$
5. MAKE NEW ASSUMPTION AND SOLVE SOLVE FOR I_C, I_B, AND β_{FORCED}