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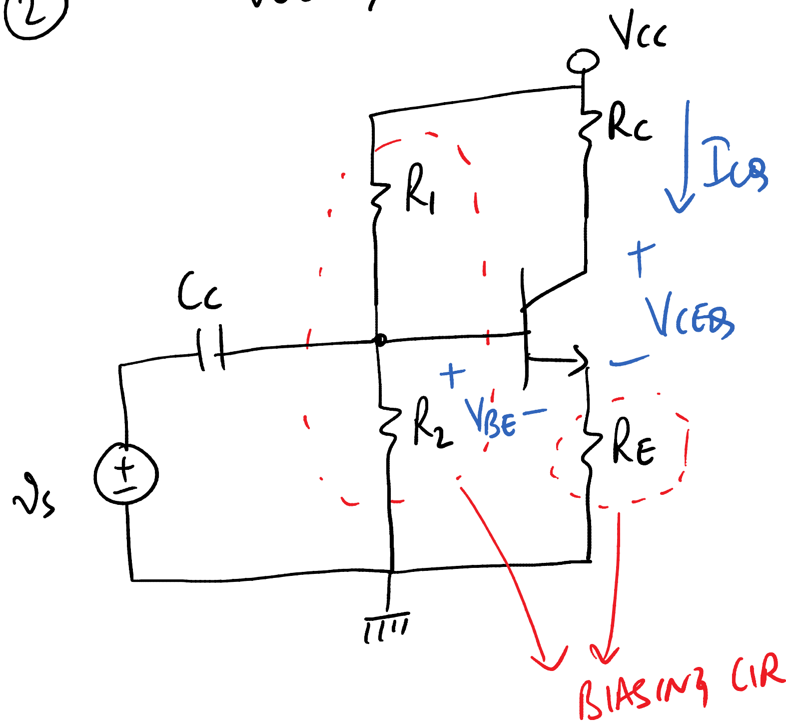
LECTURE - 30

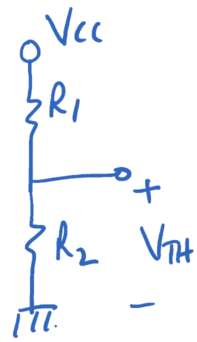
2 VOLTAGE DIVIDER BIASING

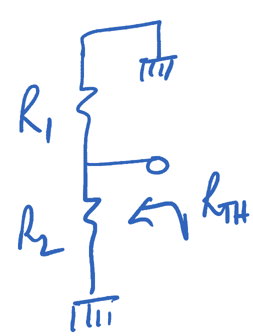


* VOLTAGE DIVIDER KEEPS BASE VOLTAGE INDEPENDENT OF BASE CURRENT

* R_E PROVIDES NEGATIVE FEEDBACK ~~AND~~ ∴ PROVIDES STABILITY AGAINST β VARIATION AND T VARIATION

1 FIND THEVENIN EQUIVALENT OF BASE CIRCUIT





$$V_{TH} = \frac{V_{CC} R_2}{R_1 + R_2}$$

$$R_{TH} = R_1 \| R_2 = \frac{R_1 R_2}{R_1 + R_2}$$

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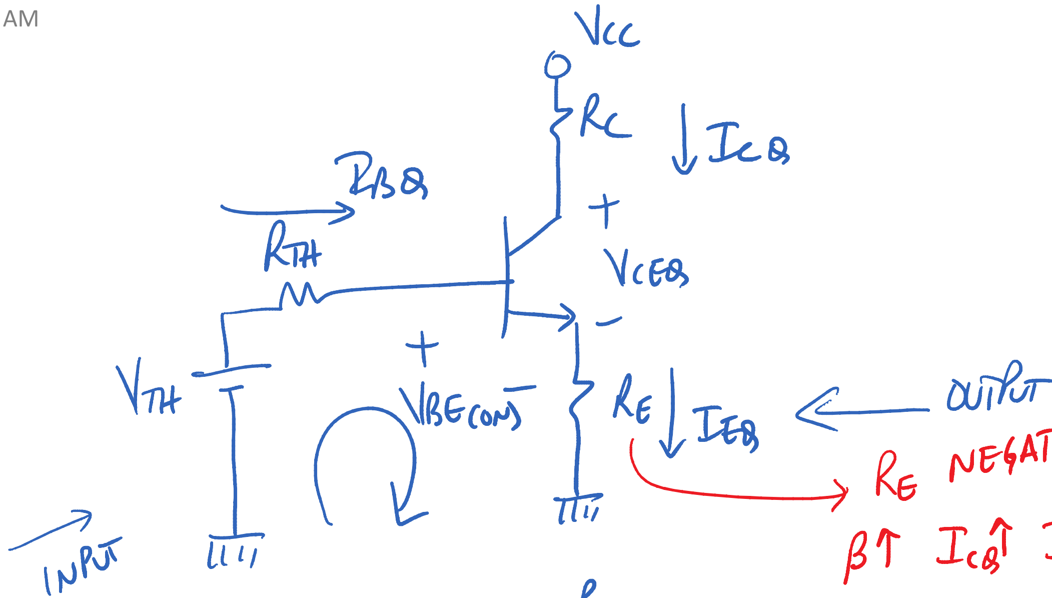

R_E NEGATIVE F/B AND STABILITY??

$\beta\uparrow \quad I_{CQ}\uparrow \quad I_{EQ}\uparrow \quad R_E I_{EQ}\uparrow$

$I_{BQ}\downarrow \quad I_{CQ}\downarrow$

KVL BE LOOP

$$-V_{TH} + I_{BQ}R_{TH} + V_{BE(ON)} + I_{EQ}R_E = 0$$

ACTIVE REGION

$$I_{EQ} = I_{BQ} + I_{CQ}$$

$$= I_{BQ} + \beta I_{BQ}$$

$$I_{EQ} = I_{BQ}(1+\beta)$$

$$I_{BQ} = \frac{V_{TH} - V_{BE(ON)}}{R_{TH} + (1+\beta)R_E} \rightarrow \uparrow$$

$$\underline{\underline{I_{CQ}}} = \beta I_{BQ}$$

Q-POINT!

KVL CE LOOP

$$-V_{CC} + I_{CQ}R_C + V_{CEQ} + I_{EQ}R_E = 0$$

$$V_{CEQ} = V_{CC} - I_{CQ}R_C - I_{EQ}R_E$$

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Ex

$R_1 = 56K\Omega$ $\quad R_2 = 12.2K\Omega$ $\quad R_C = 2K\Omega$

$\boxed{R_E = 0.4K\Omega}$ $\quad V_{CC} = 10V$ $\quad V_{BE(ON)} = 0.7V$

$\beta = 100$

CHOOSE R_E SUCH THAT $V_{RE} \approx V_{BE(ON)}$

$$R_{TH} = R_1 \parallel R_2 = 10K\Omega$$

$$V_{TH} = \left(\frac{R_2}{R_1 + R_2}\right) V_{CC} = \left(\frac{12.2K}{56K + 12.2K}\right) 10 = 1.79V$$

KVL BE LOOP

$$I_{BQ} = \frac{V_{TH} - V_{BE(ON)}}{R_{TH} + (1+\beta) R_E} = \frac{1.79 - 0.7}{10 + (101)(0.4)} = 21.6\mu A$$

$$I_{CQ} = \beta I_{BQ} = (100)(21.6\mu) = 2.16mA$$

$$I_{EQ} = (1+\beta) I_{BQ} = (101)(21.6\mu) = 2.18mA$$

$$V_{CEQ} = V_{CC} - I_{CQ} R_C - I_{EQ} R_E = 4.81V$$

$$V_{RE} = R_E I_{EQ} = (0.4K)(2.18m) = \underline{0.872V}$$

$\Downarrow \approx$

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

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β	50	100	150
Q			
I_{CQ}	1.8 mA	2.16 mA	2.32 mA
V_{CEQ}	5.67 V	4.81 V	4.4 V

1. R_1 R_2 ARE IN $K\Omega$ RANGE (LOW VALUES)
2. VARIATION IN V_{CEQ} DUE TO VARIATION IN β IS LESS
3. INCLUDING R_E STABALIZES THE Q-POINT ($\because$ OF NEGATIVE F/B)

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DESIGN REQUIREMENT FOR BIAS STABILITY!

$$\boxed{R_{TH} <<< (1+\beta) R_E}$$

$$I_{BQ} = \frac{V_{TH} - V_{BE(ON)}}{R_{TH} + (1+\beta) R_E}$$

$$I_{BQ} \approx \frac{V_{TH} - V_{BE(ON)}}{(1+\beta) R_E}$$

$$I_{CQ} \approx \cancel{\beta} \frac{V_{TH} - V_{BE(ON)}}{\cancel{(1+\beta)} R_E}$$

$$\boxed{I_{CQ} \approx \frac{V_{TH} - V_{BE(ON)}}{R_E}}$$

APPROX. INDEPENDENT OF β

$$\boxed{\begin{aligned} R_{TH} &\Rightarrow (0.1)(1+\beta) R_E \\ &\Rightarrow (0.2)(1+\beta) R_E \end{aligned}}$$

RULE OF THUMB!