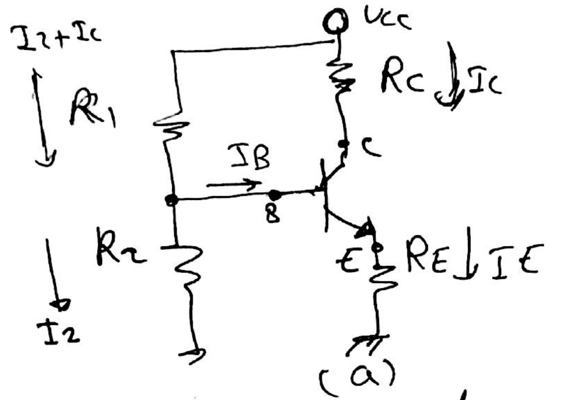
# Lec (9)
**Lec (19-20)**

## biasing Circuits (Part 2)

### [3] Voltage divider bias (most widely used)

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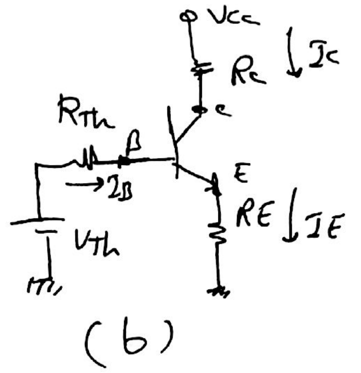



replace The Circuit with equivalent Thevenin's $R_1 V$

$$R_{Th} = R_1 // R_2$$

$$V_{Th} = \frac{V_{cc} R_2}{R_1 + R_2}$$ → voltage divider

↓ التعويض على الرسم (b)

$\therefore$ $V_{Th} - V_{BE} = I_B R_{Th} + I_E R_E$

let $I_c = \beta I_B$ $\therefore$ $I_B = I_c/\beta$ & let $I_c \simeq I_E$ → Approximation

$\therefore V_{Th} - V_{BE} = \frac{I_c}{\beta} R_{Th} + I_c R_E = I_c \left[ \frac{R_{Th}}{\beta} + R_E \right]$

$$\therefore I_c = \frac{V_{Th} - V_{BE}}{R_E + R_{Th}/\beta}$$ → أهم قانون

if $R_E \gg R_{Th}/\beta$ $\therefore I_c \simeq \frac{V_{Th} - V_{BE}}{R_E}$ & circuit more stable → not depend on $\beta$

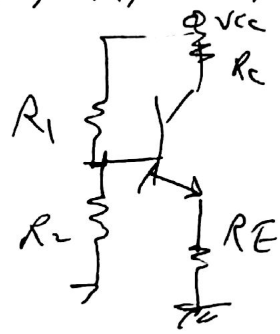
Then $$I_c \simeq \frac{V_{cc} \frac{R_2}{R_1+R_2} - V_{BE}}{R_E + \frac{1}{\beta}\left[\frac{R_1 R_2}{R_1+R_2}\right]}$$

**Also** $V_{BE} = V_B - V_E$ & $V_E \simeq I_E R_E \simeq I_c R_E$

& $V_{cc} - I_c R_c - V_{CE} - I_E R_E = 0$

$V_{CE} = V_{cc} - I_c (R_c + R_E)$ \ not depend on $\beta$

**EX(1)** Find $I_C$ and $V_{CE}$ for Voltage divider Transistor Bias of $\beta = 100$, $V_{CC} = 10V$, $R_C = 1k$, $R_E = 560\Omega$, $R_1 = 10k$, $R_2 = 5.6k$




**Sol**

$$V_B = V_{CC}\frac{R_2}{R_1+R_2} = V_{th}$$

$$= \frac{10 \times 5.6k}{(10+5.6)k} = 3.59V$$

تقريبي

$$I_C \cong \frac{V_E}{R_E} \cong \frac{V_B - V_{BE}}{R_E} = \frac{3.59-0.7}{560} = 5.16mA$$

$$V_{CE} = V_{CC} - I_C(R_C + R_E) = 12 - 5.6\times10^{-3}(1000+560) = 1.95V$$

دقيق

$$I_E = \frac{V_{th} - V_{BE}}{\frac{R_{th}}{\beta} + R_E} = \frac{3.59 - 0.7}{560 + \frac{(560 // 1k)}{100}} \simeq 5.13\,mA$$

ونكمل نفس الطريقة

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effect of I/p Resistance (Page 75 لا تلزمك)

ملحق

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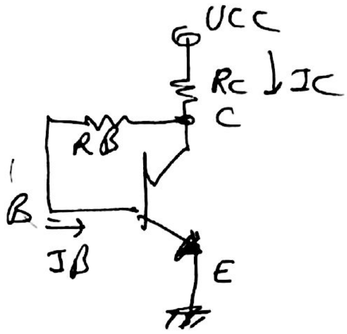
## (4) Collector feedback bias




$$I_B = \frac{V_C - V_B}{R_B}$$

$V_{BE} = V_B - V_E = V_B$ ($V_E \to 0$)

$$\therefore \boxed{I_B = \frac{V_C - V_{BE}}{R_B}} \longrightarrow (1)$$

for $I_C \gg I_B$ $\therefore I_C + I_B \simeq I_C$ or $I_E \simeq I_C$

$V_{CE} = V_C - V_E = V_C = V_{CC} - I_C R_C$ ($V_E \to 0$)

$$\therefore V_C = \boxed{V_{CE} = V_{CC} - I_C R_C} \longrightarrow (2)$$

$$\boxed{I_C = \beta I_B} \longrightarrow (3)$$

بالتعويض (1)

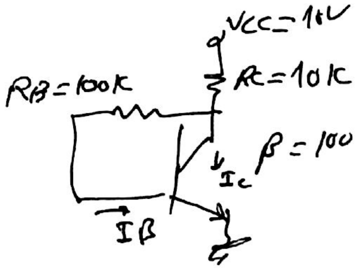
$$\therefore I_C = \beta \left[\frac{V_C - V_{BE}}{R_B}\right] = \beta \left[\frac{V_{CC} - I_C R_C - V_{BE}}{R_B}\right]$$

$$\therefore \frac{I_C R_B}{\beta} = V_{CC} - I_C R_C - V_{BE}$$

$$I_C \left[\frac{R_B}{\beta} + R_C\right] = V_{CC} - V_{BE}$$

$$\therefore \boxed{I_C = \frac{V_{CC} - V_{BE}}{\frac{R_B}{\beta} + R_C}} \longrightarrow (4)$$

EX(2) Calc. Q point values ($I_C, V_{CE}$) for shown ckt




Sol

$$I_C = \frac{V_{CC} - V_{BE}}{R_C + R_B/\beta} = \frac{10 - 0.7}{10\times10^3 + \frac{100\times10^3}{100}} = 0.845\,mA$$

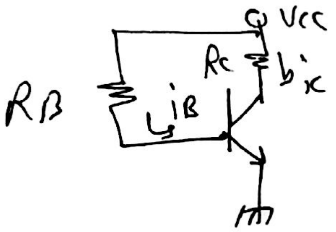
$$V_{CE} = V_{CC} - I_C R_C = 10 - (0.845\times10^{-3})(10\times10^3) = 1.55\,V$$

(Page 77) خلاصة ال biasing

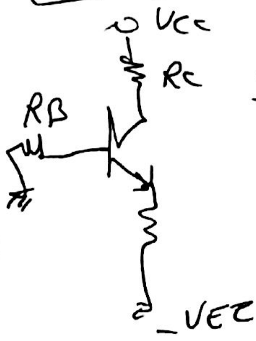
## 1 base bias

$$I_C = \beta\left(\frac{V_{CC} - V_{BE}}{R_B}\right)$$

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



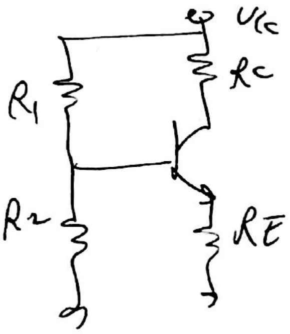

## 2 emitter Bias




$$I_C = \frac{V_{EE} - V_{BE}}{R_E + R_B/\beta}$$

$$V_{CE} = (V_{CC} + V_{EE}) - I_C(R_C + R_E)$$

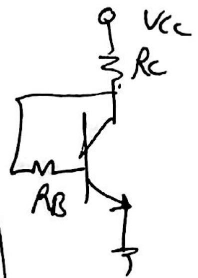
## 3 Voltage divider bias




$$I_C = \frac{V_{CC}\dfrac{R_2}{R_1+R_2} - V_{BE}}{R_E}$$

$$V_{CE} = V_{CC} - I_C(R_C + R_E)$$

## 4 Collector Bias




$$I_C = \frac{V_{CC} - V_{BE}}{R_C + R_B/\beta}$$

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

يوجد
مسائل محلولة هامة بالمذكرة

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