University of Anbar
College of Engineering
Dept. of Electrical Engineering

Fundumantal of Electronic I

Second Class

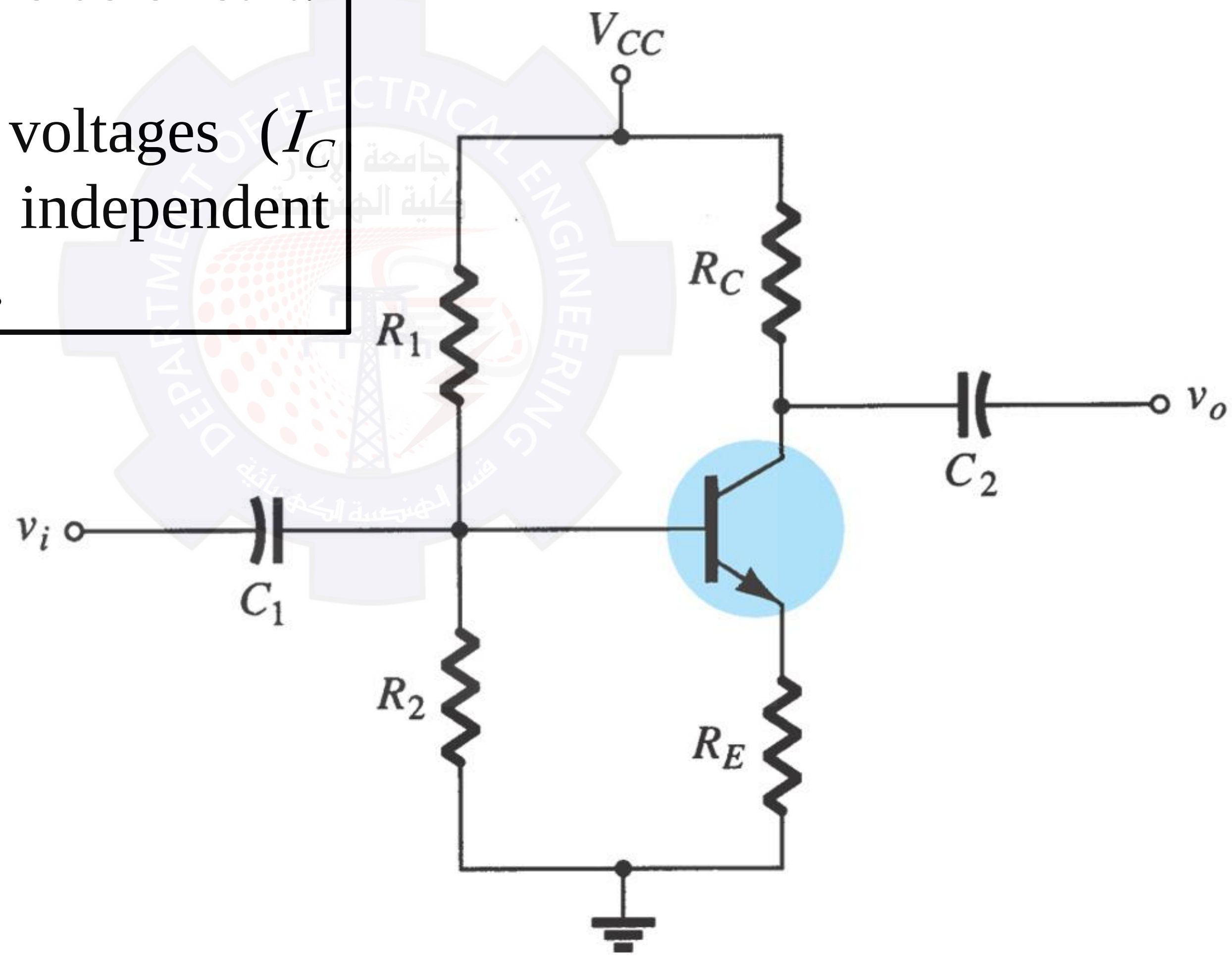
Chapter 4 : DC Biasing – BJTs
Lec04_p2

Munther N. Thiyab

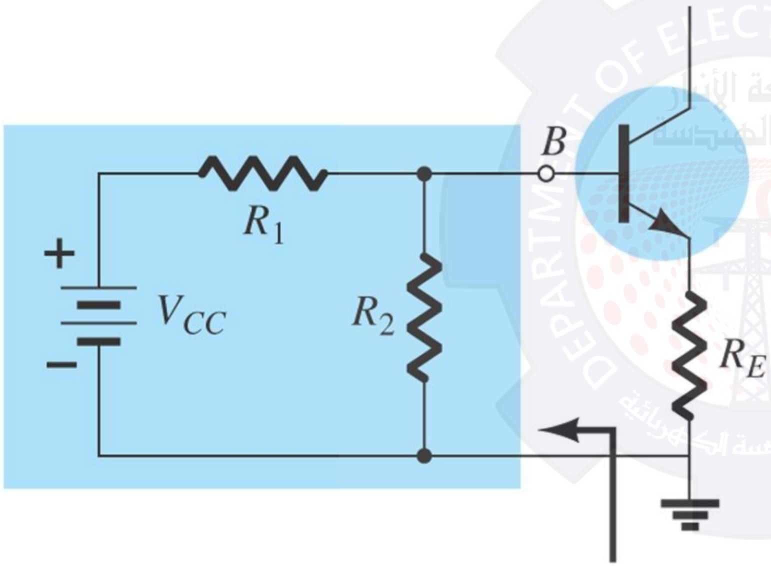
2019-2020

Voltage Divider Bias

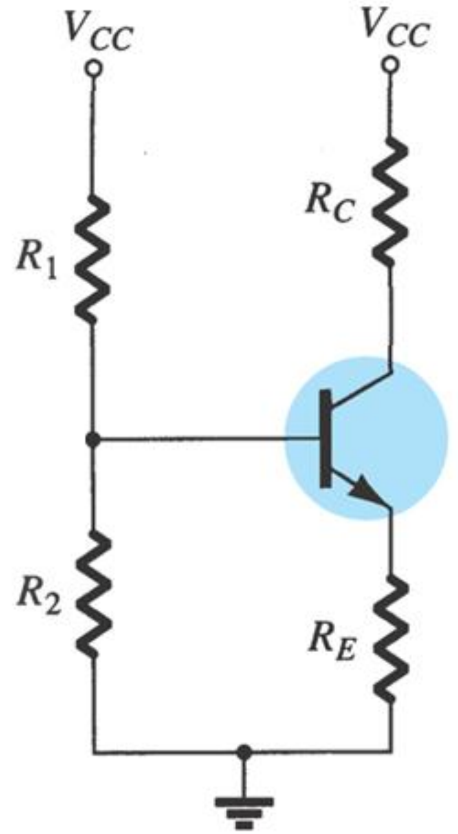
- This is a very stable bias circuit.
- The currents and voltages (I_C and V_{CE}) are nearly independent of any variations in β.



Voltage Divider Bias Analysis

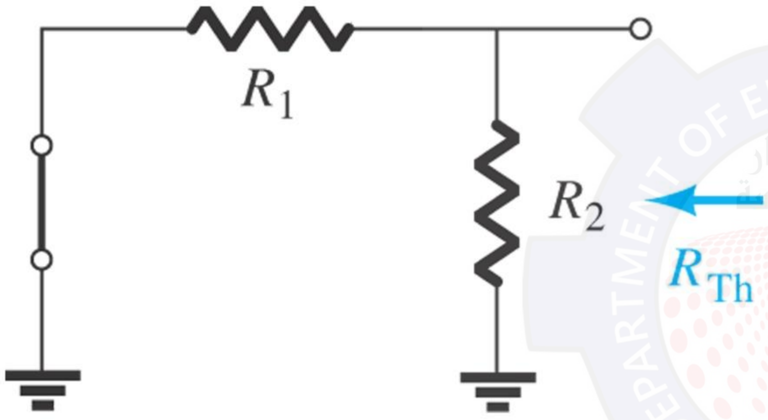


Redrawing the input side of the network.

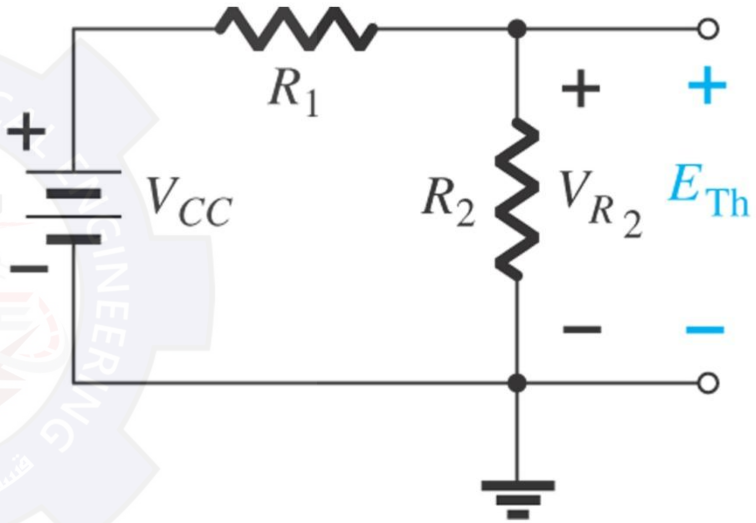


DC Circuit

Voltage Divider Bias Analysis



Determining R_{TH}

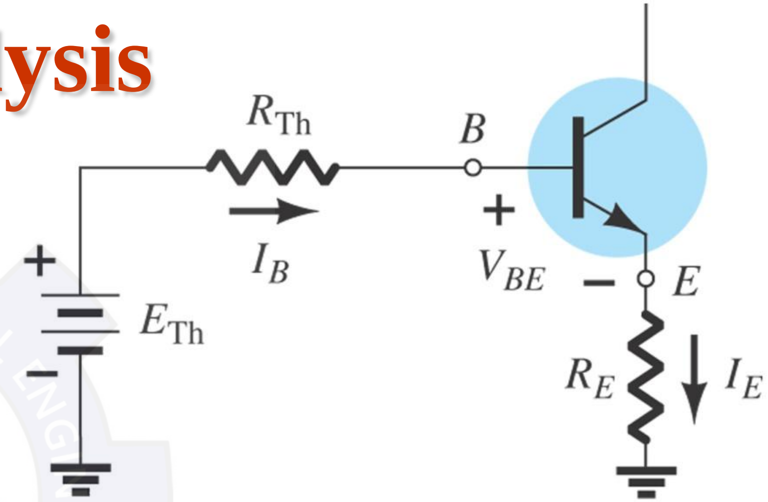


Determining E_{TH}.

$$R_{th} = R_1 \parallel R$$

$$E_{th} = V_{R2} \quad \frac{R_2 \ V_{CC}}{R_1 +}$$

Voltage Divider Bias Analysis



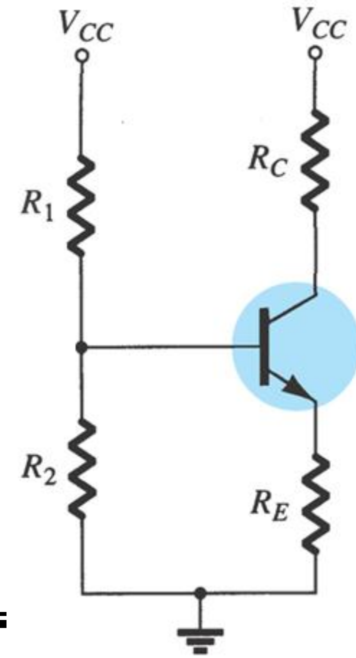
Inserting the Thévenin equivalent circuit.

$$E_{th} - I_B R_{TH} - V_{BE} - I_E R_E = 0$$

$$I_E \quad (\beta + 1) \quad B$$

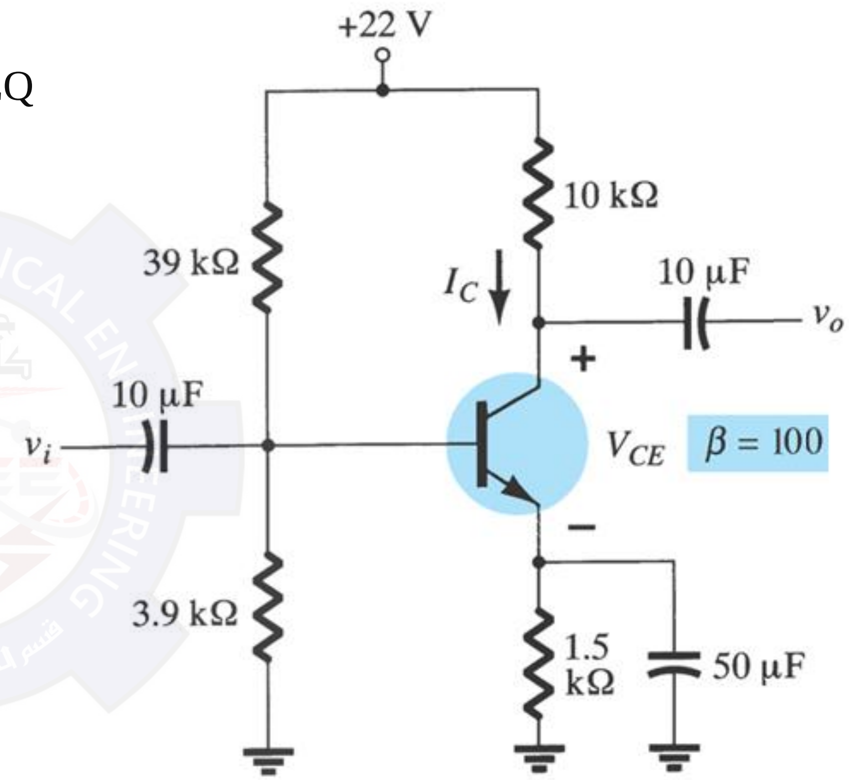
$$I_B = \frac{E_{th} - \quad _{BE}}{R_{TH} \quad (\beta + 1) R_E}$$

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



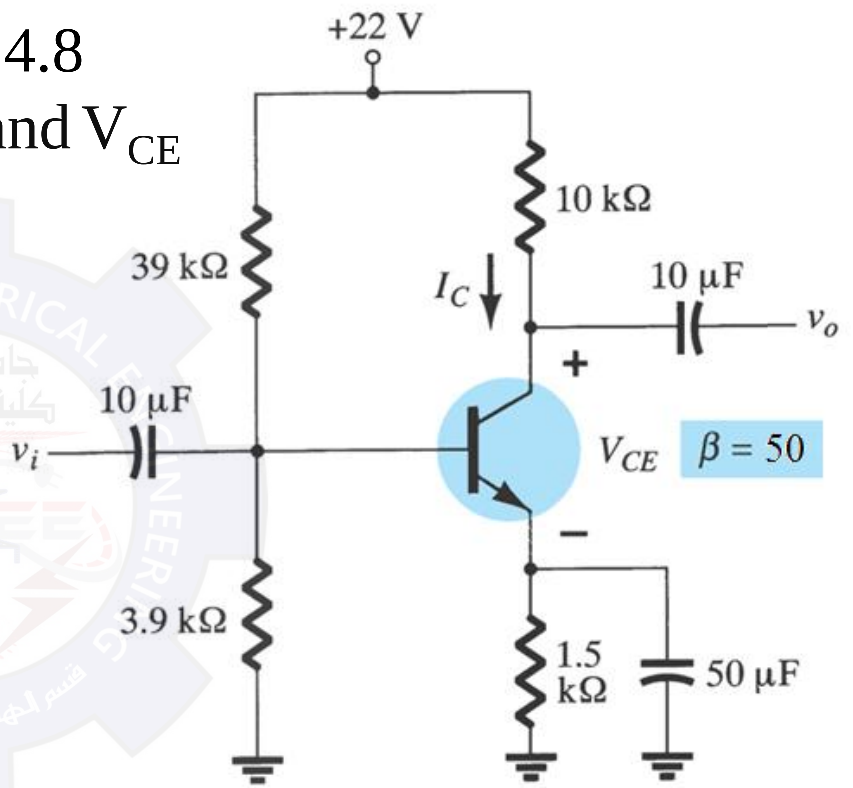
Example 4.8

Find I_{CQ} , V_{CEQ}



Example 4.10

Repeat example 4.8 with β=50. compare solutions for I_C and V_{CE}

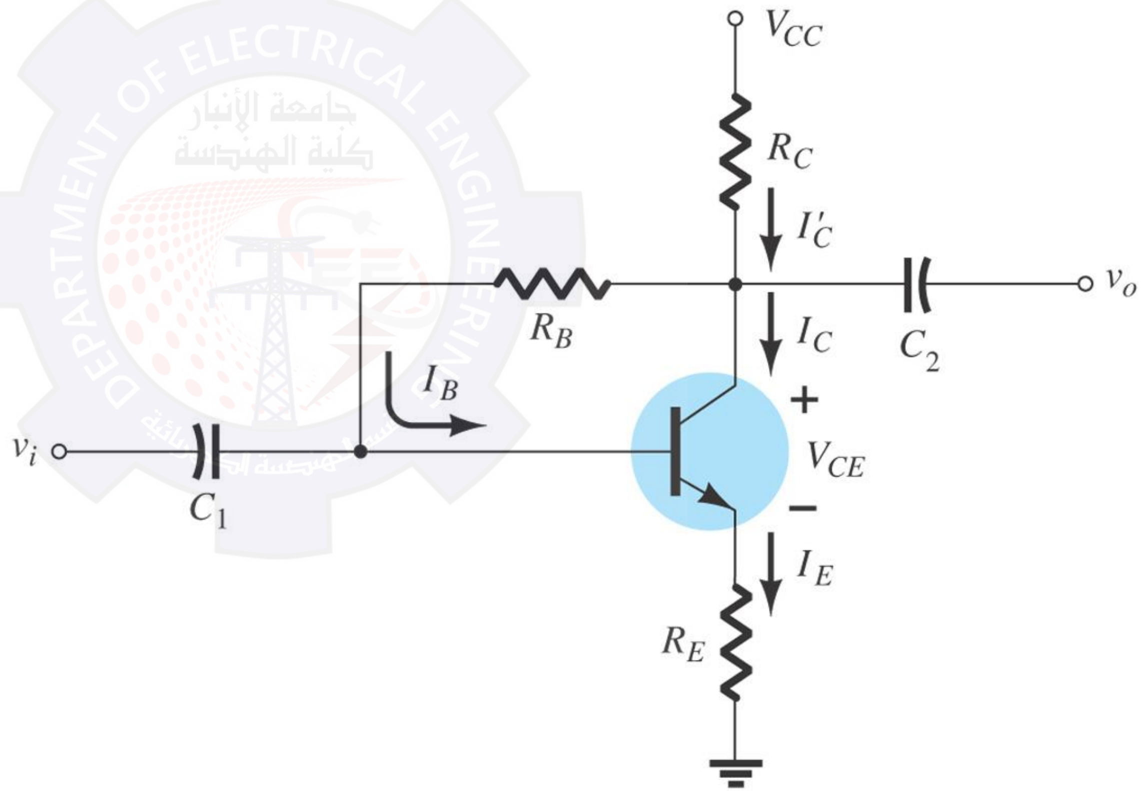


β	I_C(mA)	V_{CE} (V)
100	0.84 mA	12.34 V
50	0.81 mA	12.69 V

Collector Feedback Configuration

- Another way to improve the stability of a bias circuit is to add a feedback path from collector to base.

- In this bias circuit the Q-point is only slightly dependent on the transistor beta, β.



Base-Emitter Loop

From Kirchhoff's voltage law:

$$V_{CC} - I'_C R_C - I_B R_B - V_{BE} - I_E R_E = 0$$

Since $I_B << I_C$:

$$I'_C = I_C + I_B \cong I_C$$

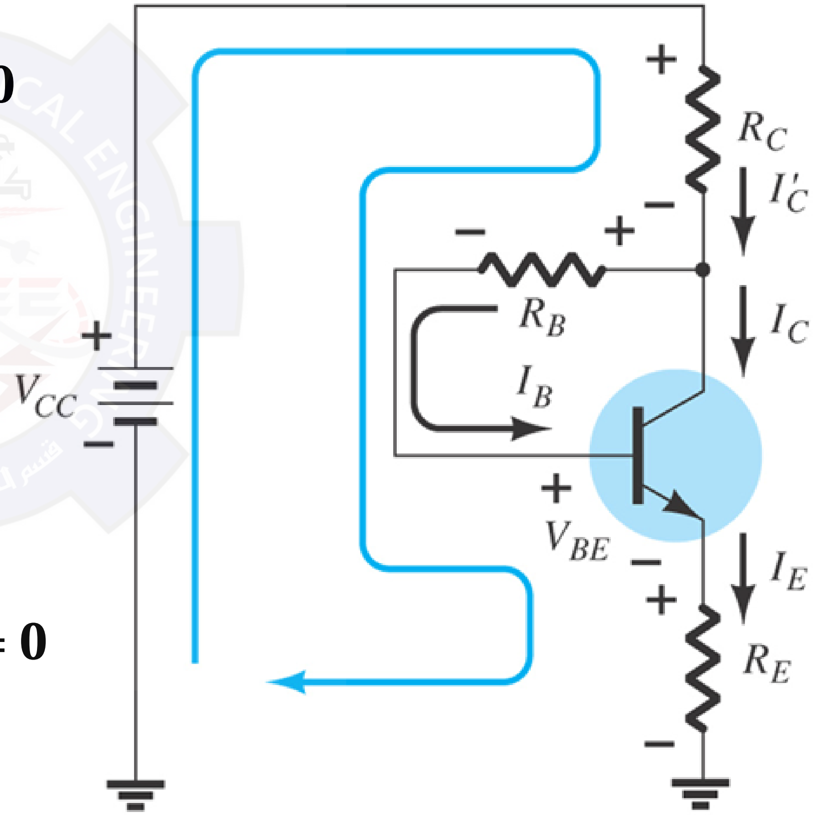
Knowing $I_C = \beta I_B$ and $I_E \cong I_C$, the loop equation becomes:

$$V_{CC} - \beta I_B R_C - I_B R_B - V_{BE} - \beta I_B R_E = 0$$

Solving for I_B:

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta(R_C + R_E)}$$

$$I_C = \beta I$$



Collector-Emitter Loop

Applying Kirchoff's voltage law:

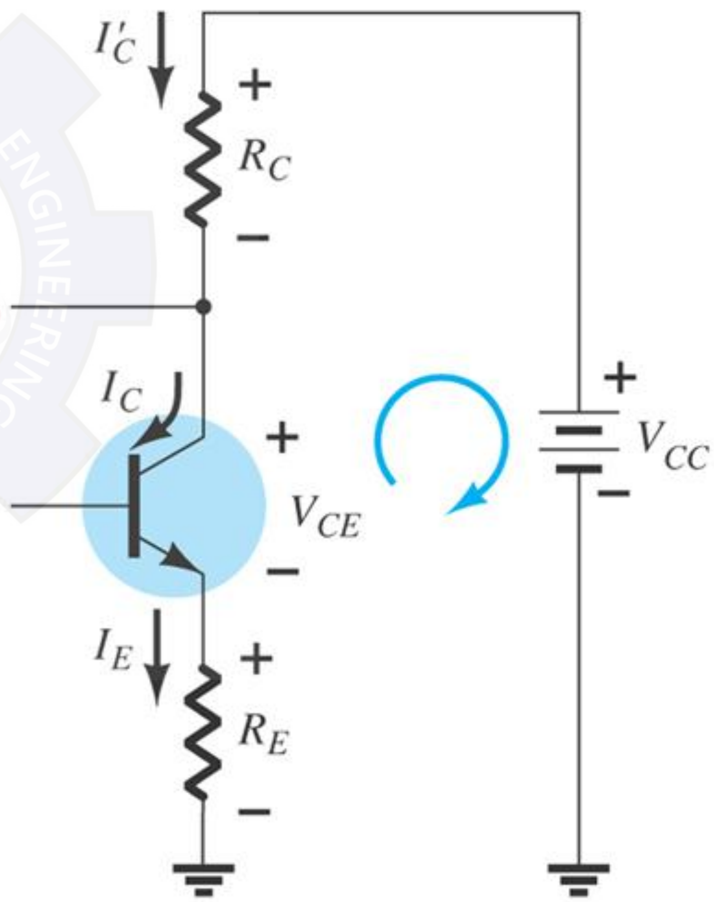
$$I_E R_E + V_{CE} + I'_C R_C - V_{CC} = 0$$

Since $I'_C \cong I_C$ and $I_E \cong I_C$:

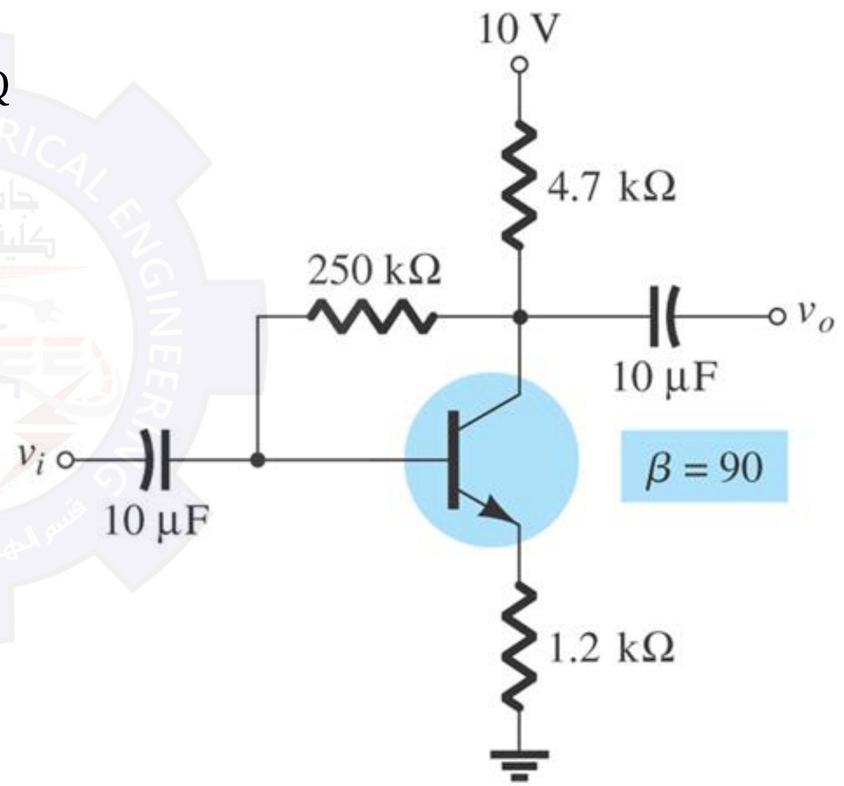
$$I_C(R_C + R_E) + V_{CE} - V_{CC} = 0$$

Solving for V_{CE}:

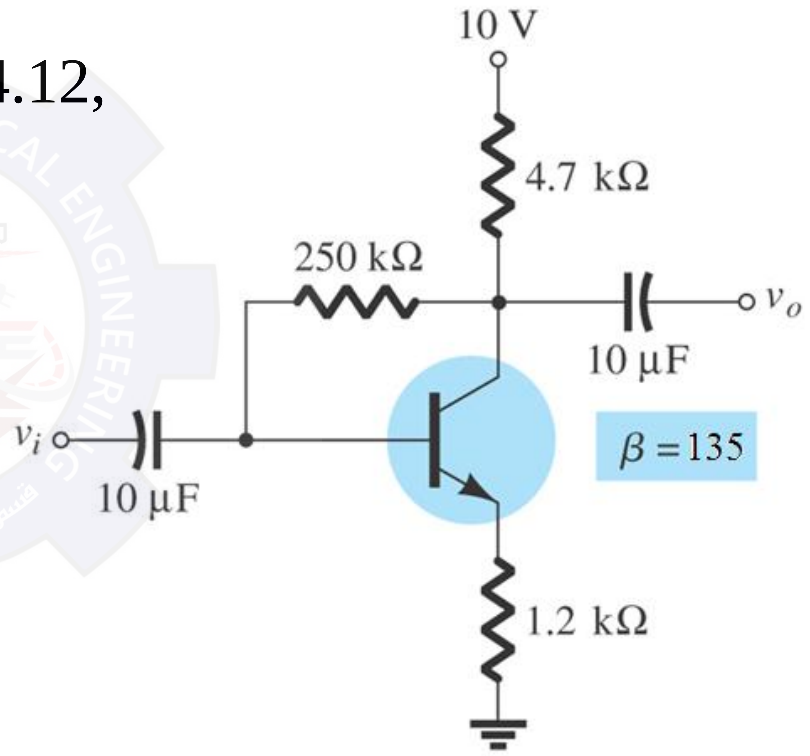
$$V_{CE} = V_{CC} - I_C (R_C + R_E)$$



Example 4.12 Find I_{CQ} , V_{CEQ}



Example 4.13 Repeat example 4.12, with β=135. (Find I_{CQ}, V_{CEQ}).



Example 4.14

Determine the DC level of I_B and V_C.