



Fundumantal of Electronic I

Second Class

Chapter 4 : DC Biasing – BJTs

Lec04_p1

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Biassing

Biassing: The DC voltages applied to a transistor in order to turn it on so that it can amplify the AC signal.

Recall the following basic relationships for a transistor:

$$V_{BE} = 0.7 \text{ V}$$

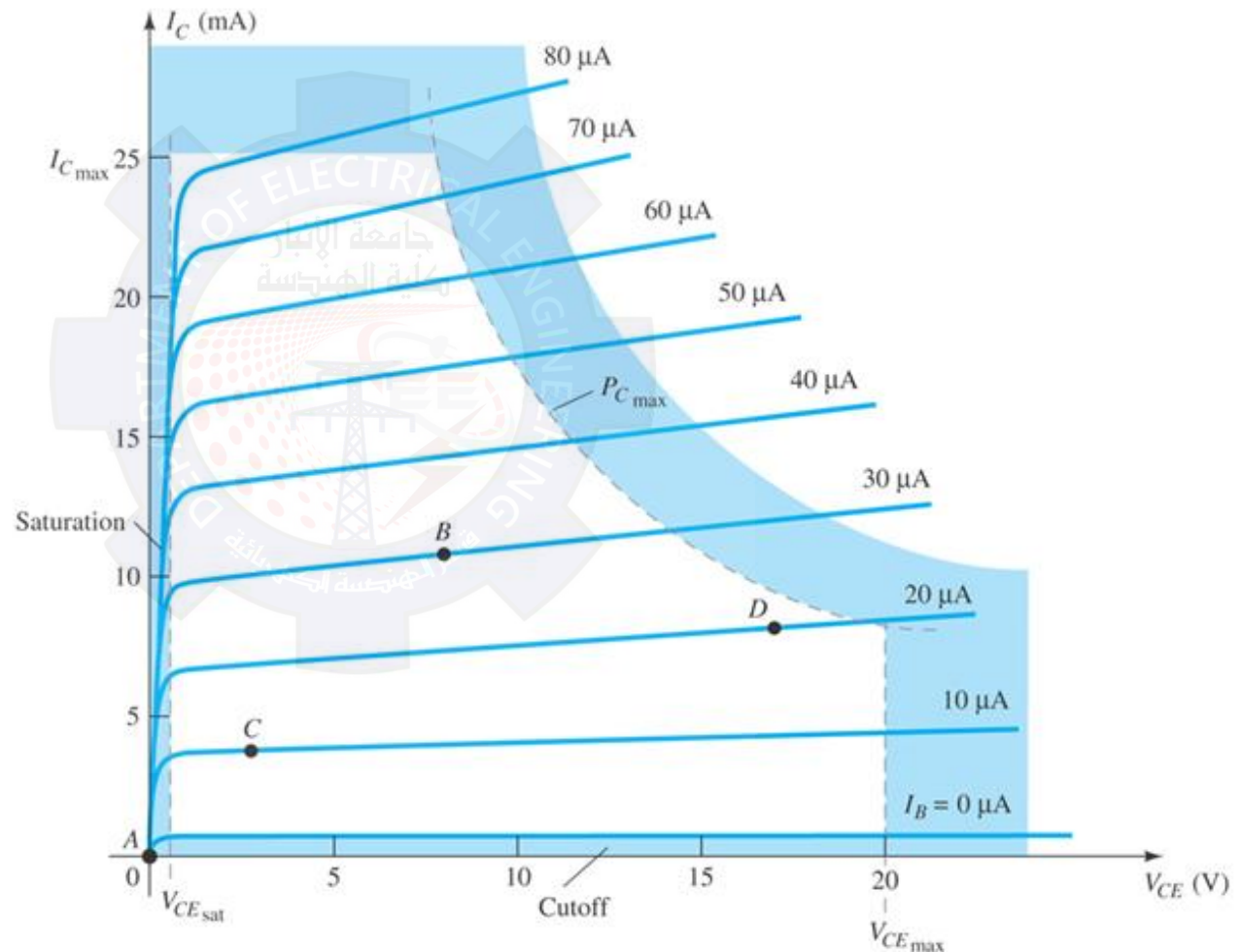
$$I_E = (\beta + 1)I_\beta$$

$$I_C = \beta I_\beta$$



Operating Point

The DC input establishes an operating or *quiescent point* called the ***Q-point***.



Various operating points within the limits of operation of a transistor.



The Three States of Operation

- **Active or Linear Region Operation**
Base–Emitter junction is forward biased
Base–Collector junction is reverse biased
- **Cutoff Region Operation**
Base–Emitter junction is reverse biased
- **Saturation Region Operation**
Base–Emitter junction is forward biased
Base–Collector junction is forward biased

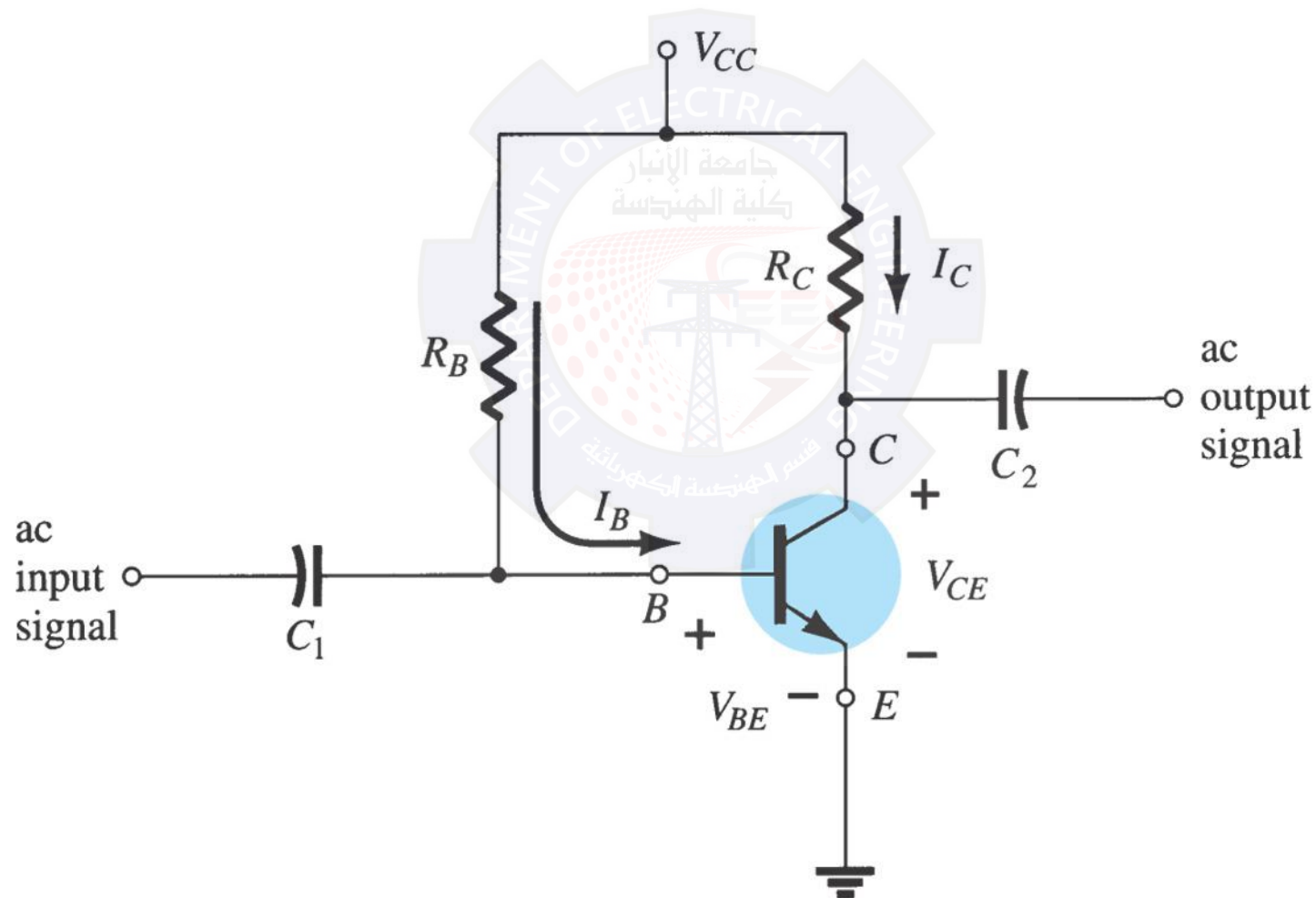


DC Biasing Circuits

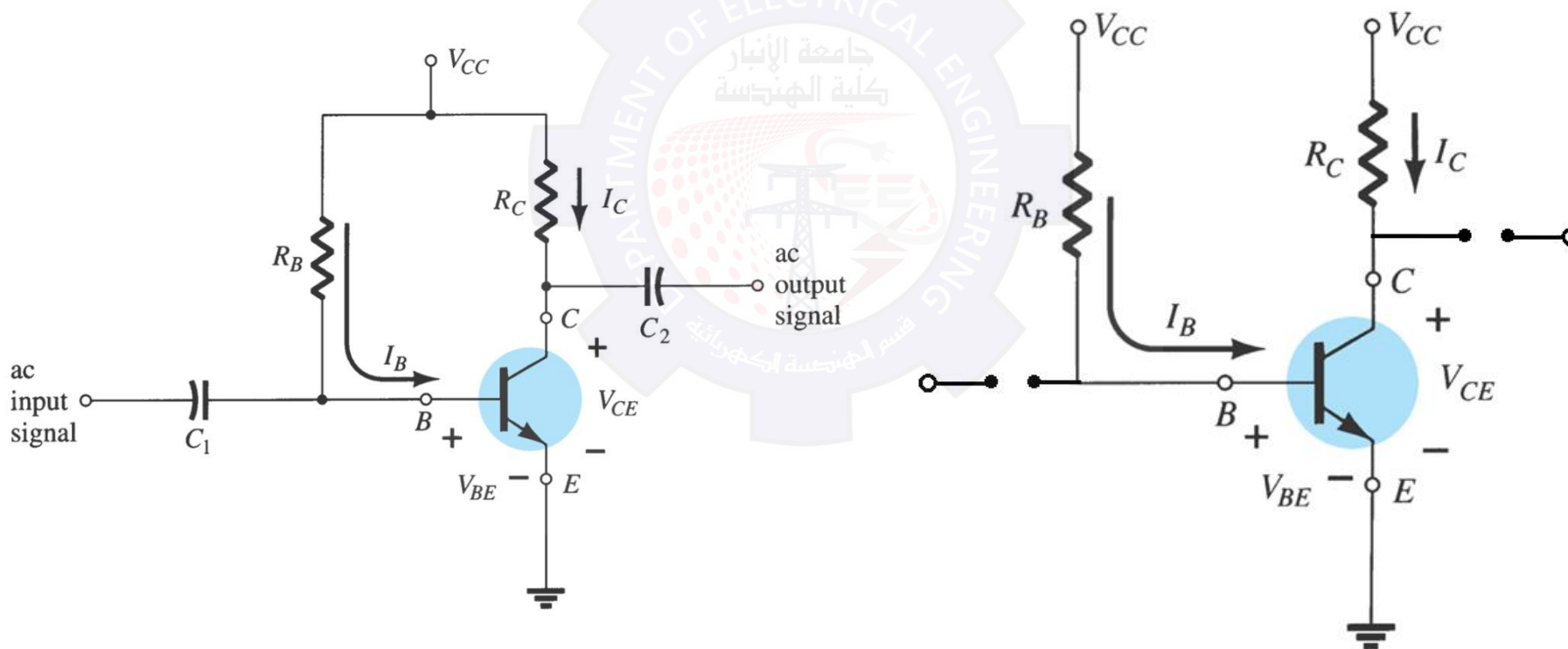
- **Fixed-bias circuit**
- **Emitter-stabilized bias circuit**
- **Collector-emitter loop**
- **Voltage divider bias circuit**
- **DC bias with voltage feedback**



Fixed Bias configuration



Fixed Bias configuration



Fixed bias circuit

DC equivalent



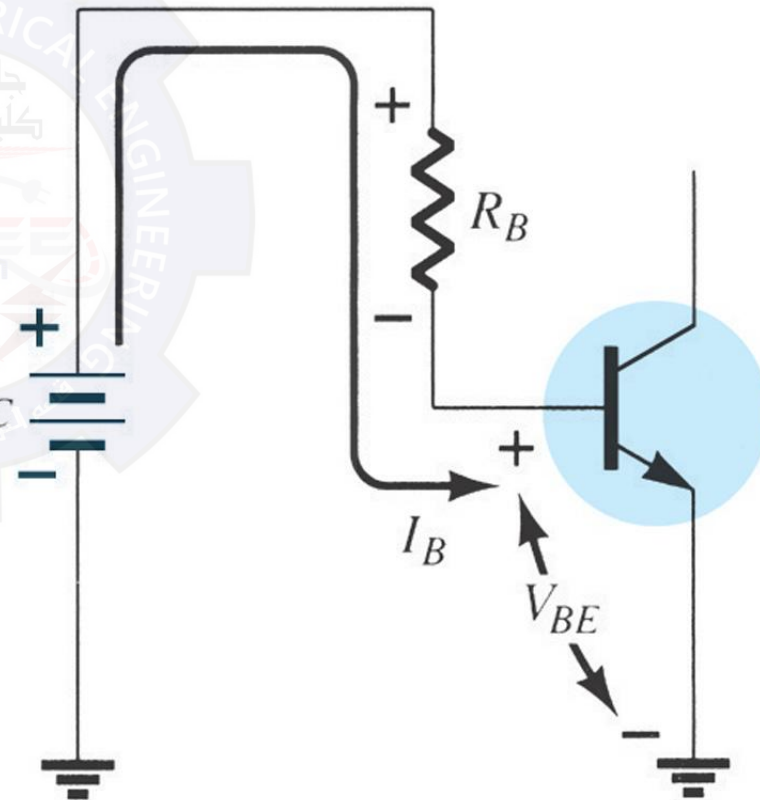
The Base-Emitter Loop

From Kirchhoff's voltage law:

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

Solving for base current:

$$I_B = \frac{V_{CC} - V_{BE}}{R_B}$$





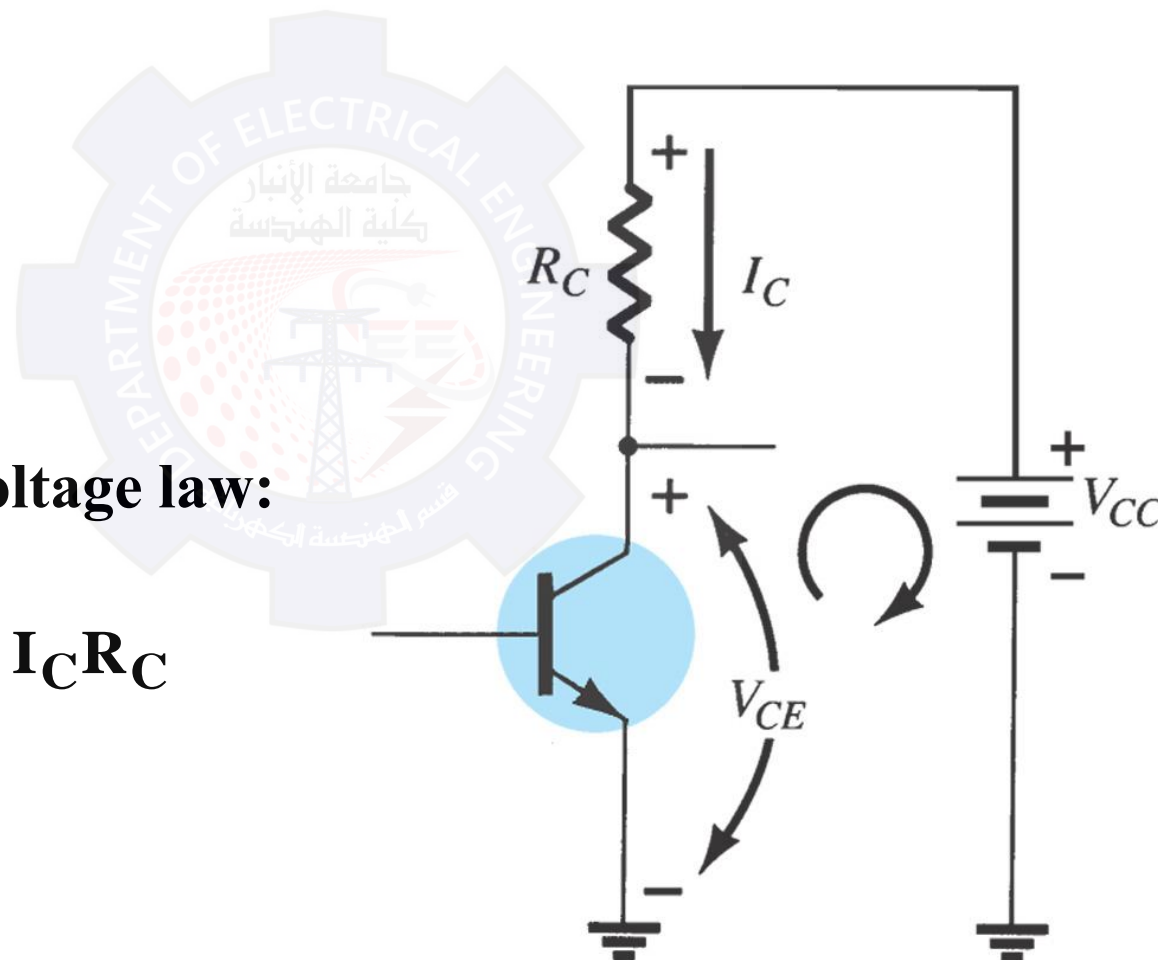
Collector-Emitter Loop

Collector current:

$$I_C = \beta I_B$$

From Kirchhoff's voltage law:

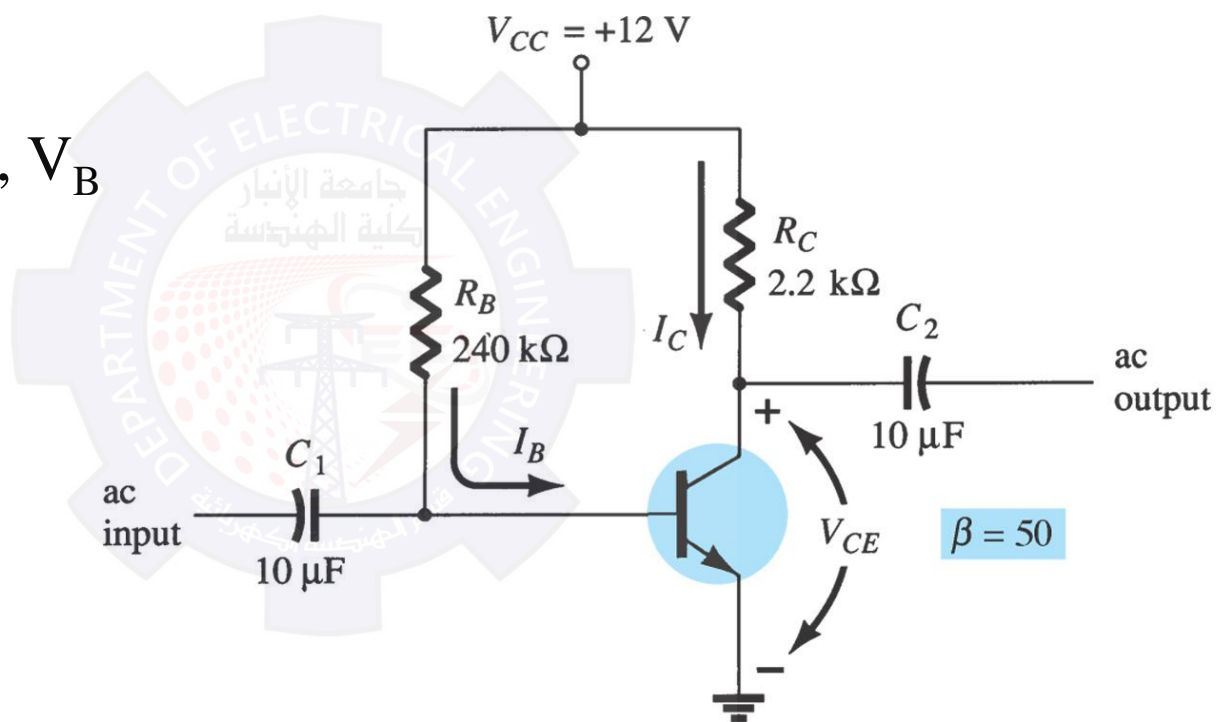
$$V_{CE} = V_{CC} - I_C R_C$$





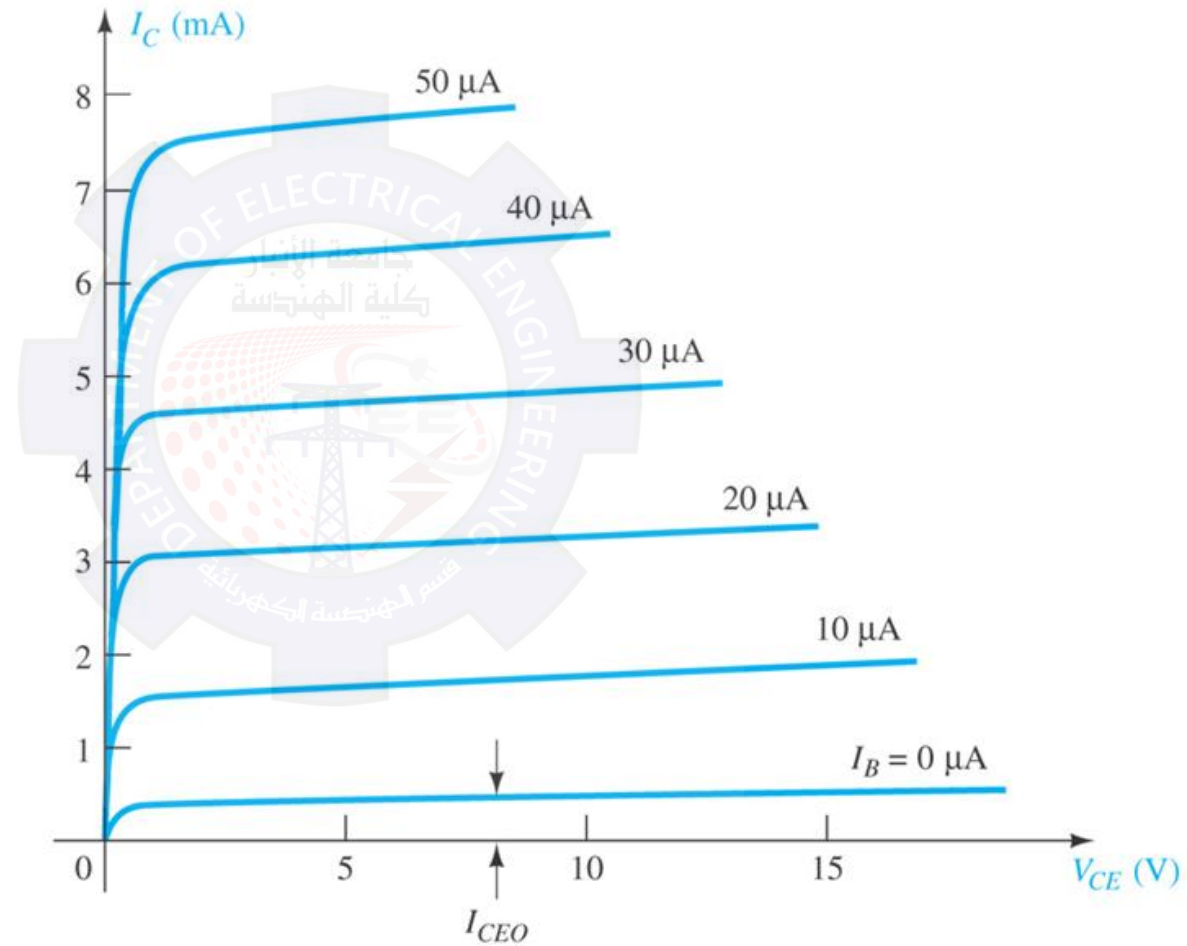
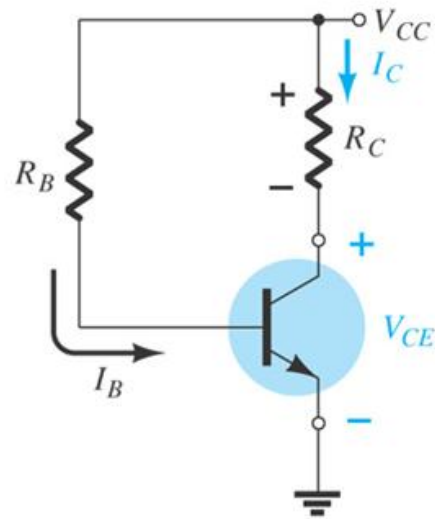
Example 4.1

Find I_{BQ} , I_{CQ} , V_{CEQ} , V_B ,
 V_C , V_{BC} .





Load Line Analysis



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

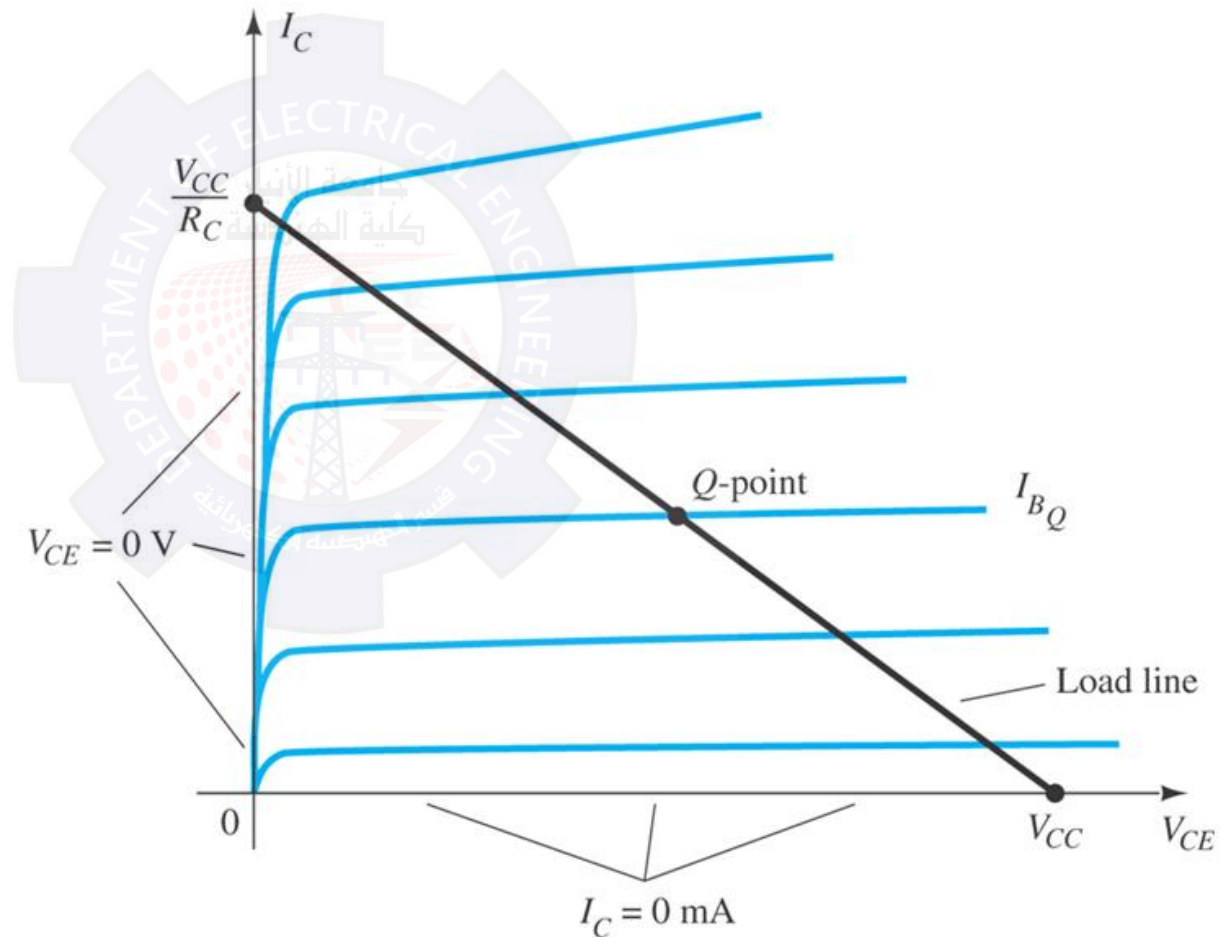


Load Line Analysis

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

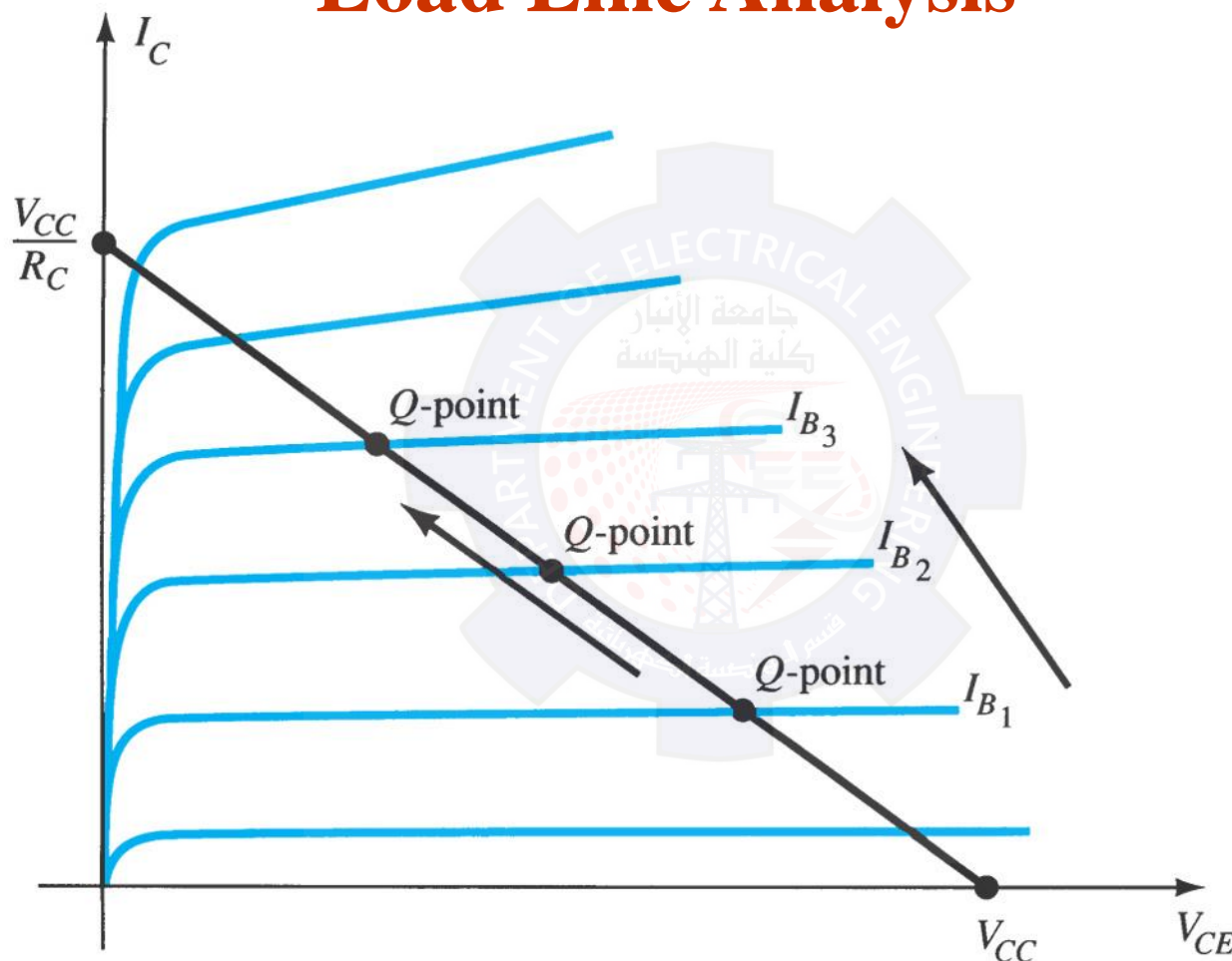
$$V_{CE} = V_{CC} \Big|_{I_C = 0 \text{ mA}}$$

$$I_C = \frac{V_{CC}}{R_C} \Big|_{V_{CE} = 0 \text{ V}}$$





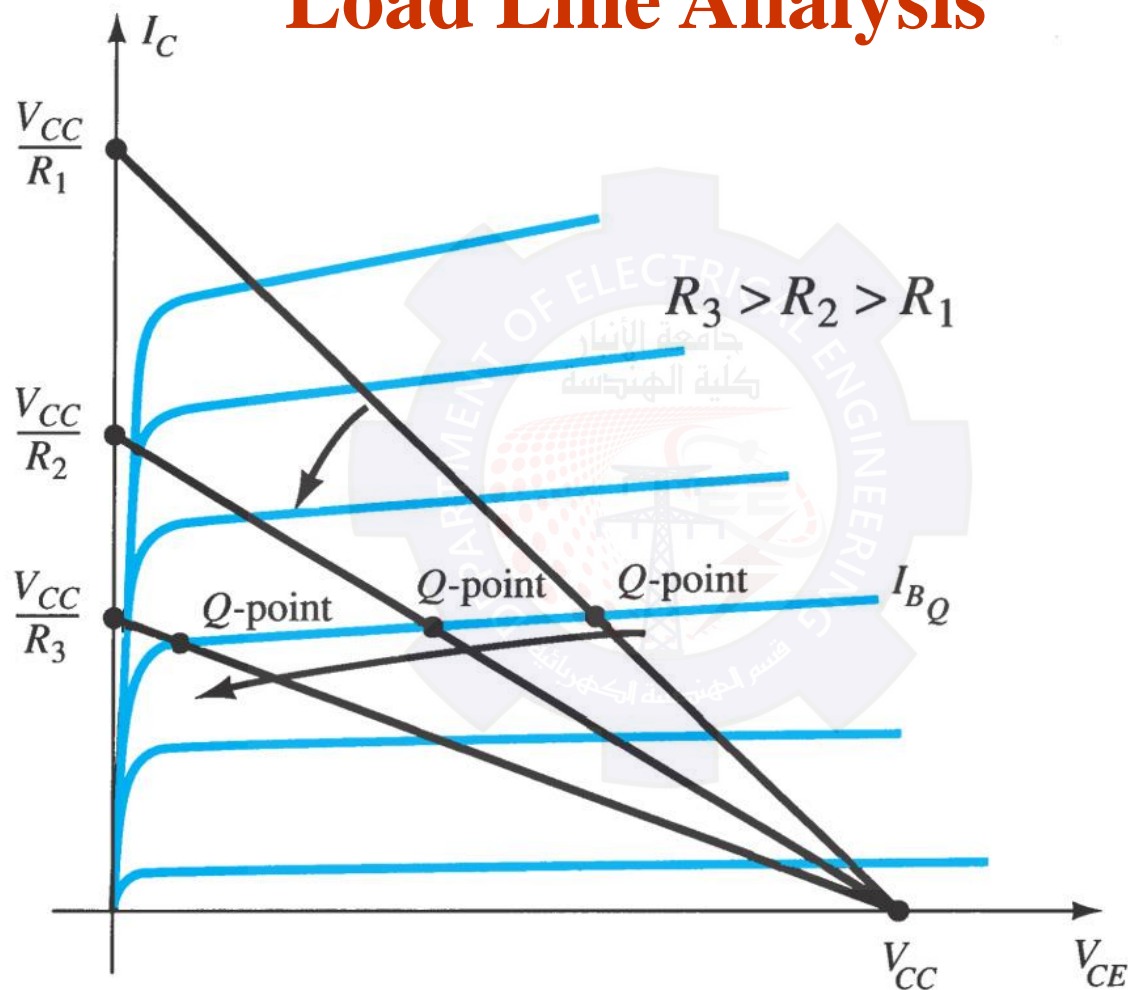
Load Line Analysis



Movement of the Q -point with increasing level of I_B .
(The level of I_B is changed by varying the value of R_B)



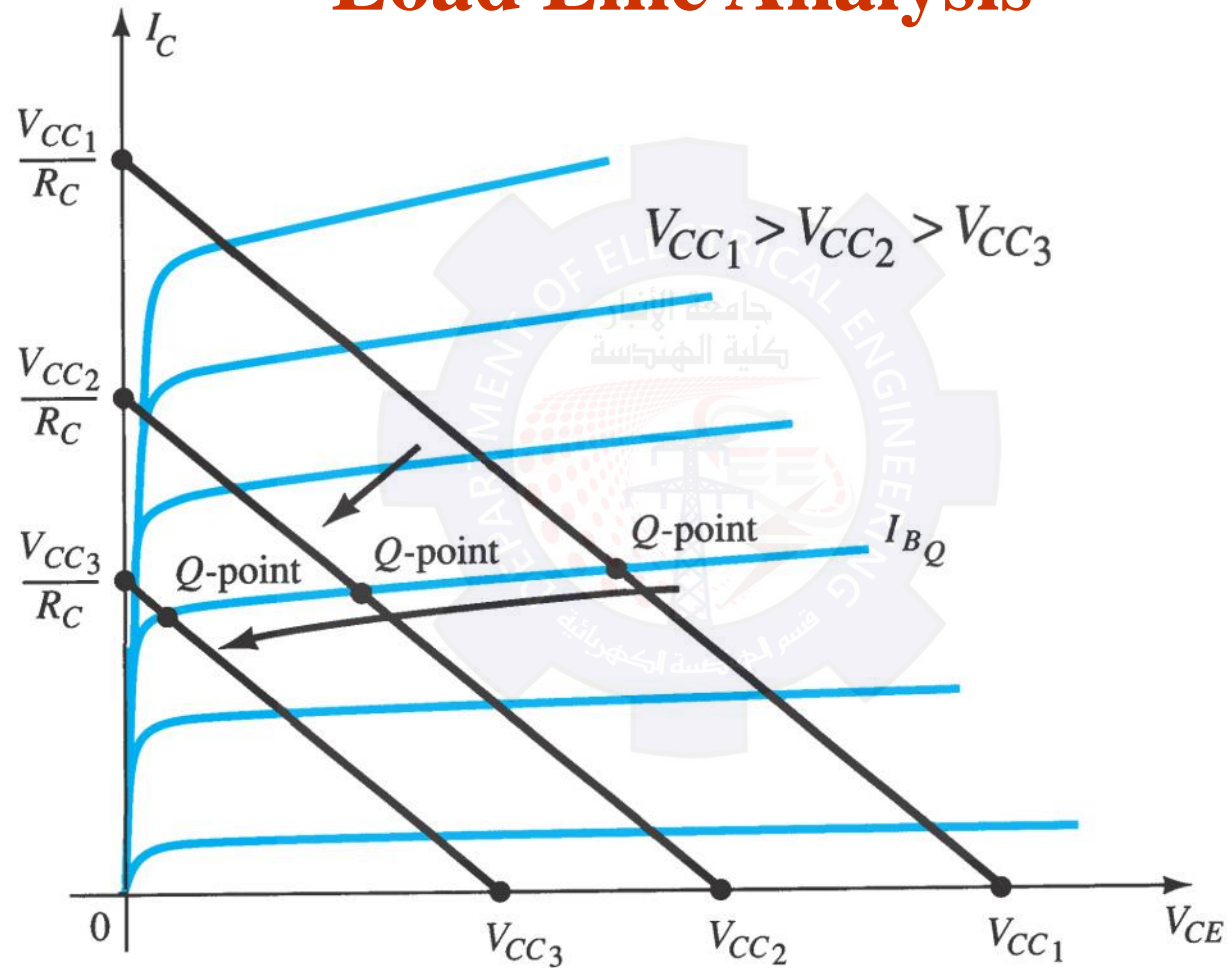
Load Line Analysis



Effect of an increasing level of R_C on the load line and the Q -point.
(V_{CC} fixed)



Load Line Analysis

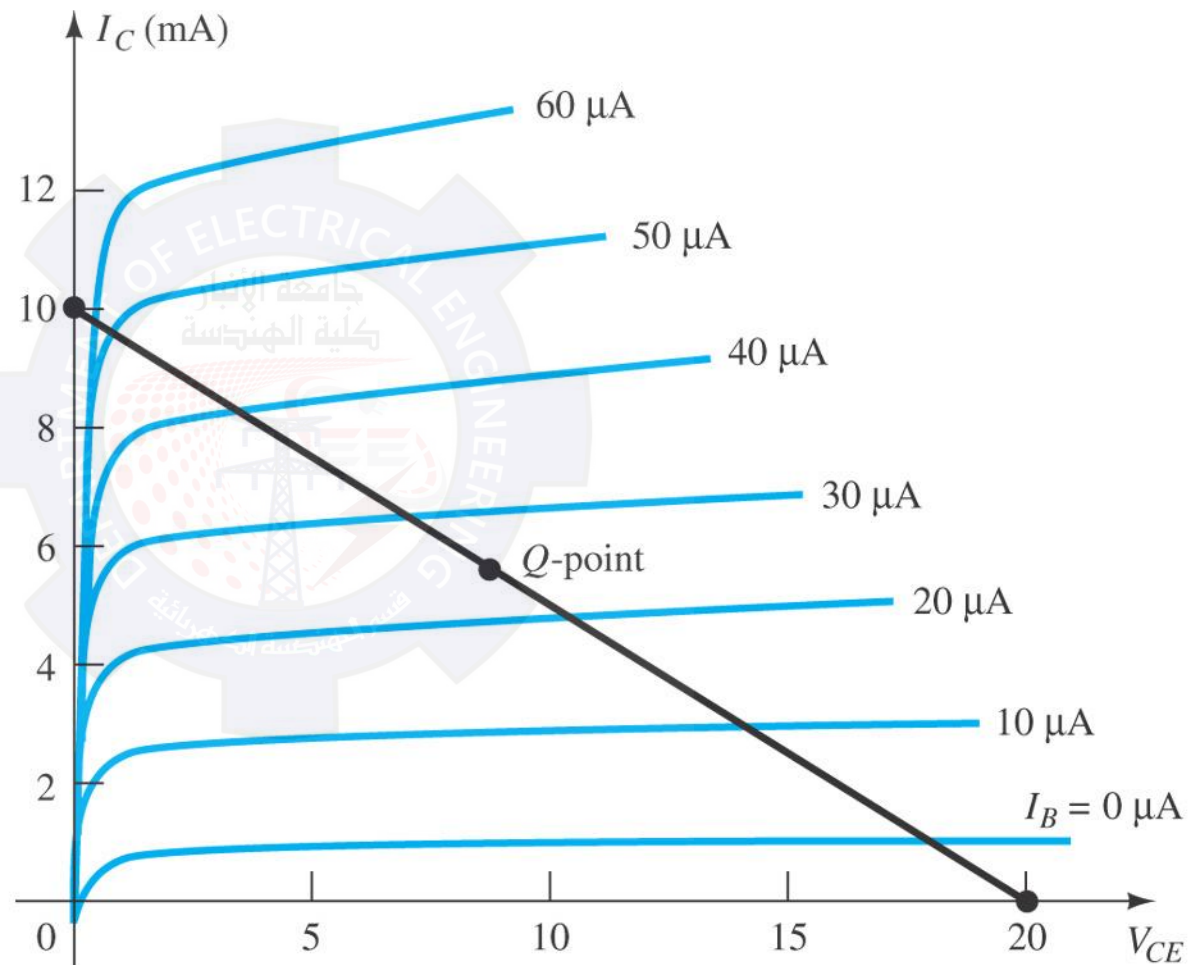


Effect of lower values of V_{CC} on the load line and the Q -point.



Example 4.3

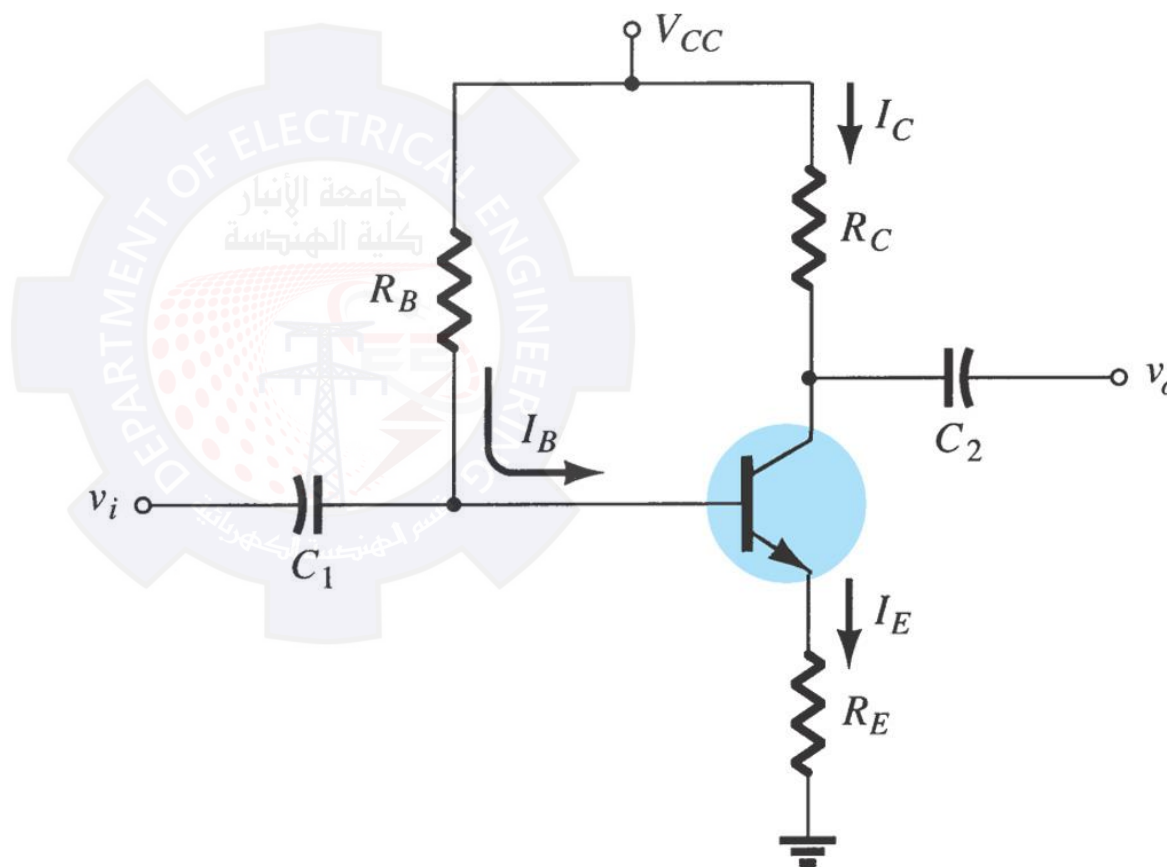
Find V_{CC} , R_C , R_B for the fixed biasing configuration





Emitter-Stabilized Bias Circuit

Adding a resistor (R_E) to the emitter circuit stabilizes the bias circuit.



Base-Emitter Loop

From Kirchhoff's voltage law:

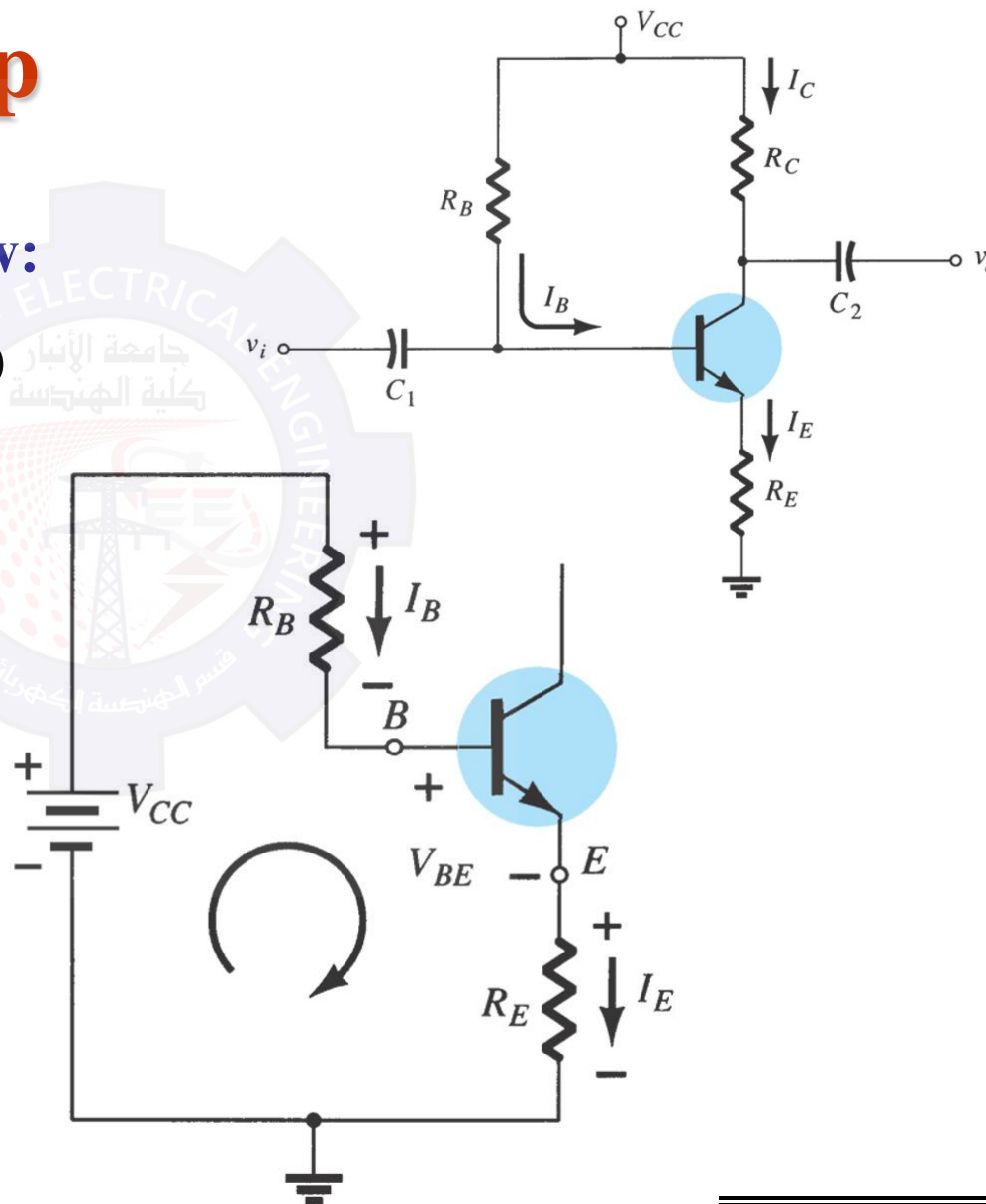
$$+ V_{CC} - I_E R_E - V_{BE} - I_E R_E = 0$$

Since $I_E = (\beta + 1)I_B$:

$$V_{CC} - I_B R_B - (\beta + 1)I_B R_E = 0$$

Solving for I_B :

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta + 1)R_E}$$



Collector-Emitter Loop

From Kirchhoff's voltage law:

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

Since $I_E \cong I_C$:

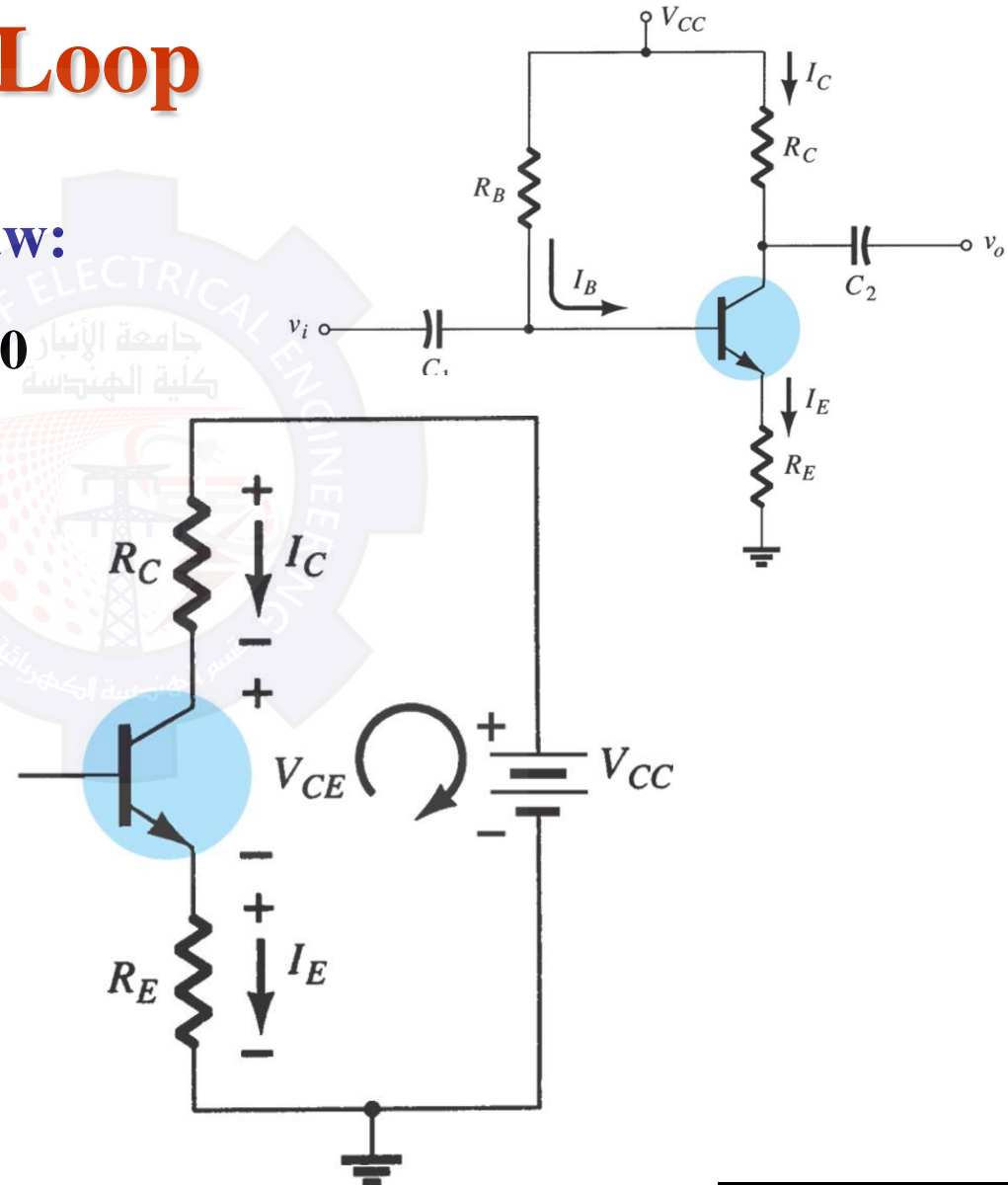
$$V_{CE} = V_{CC} - I_C (R_C + R_E)$$

Also:

$$V_E = I_E R_E$$

$$V_C = V_{CE} + V_E = V_{CC} - I_C R_C$$

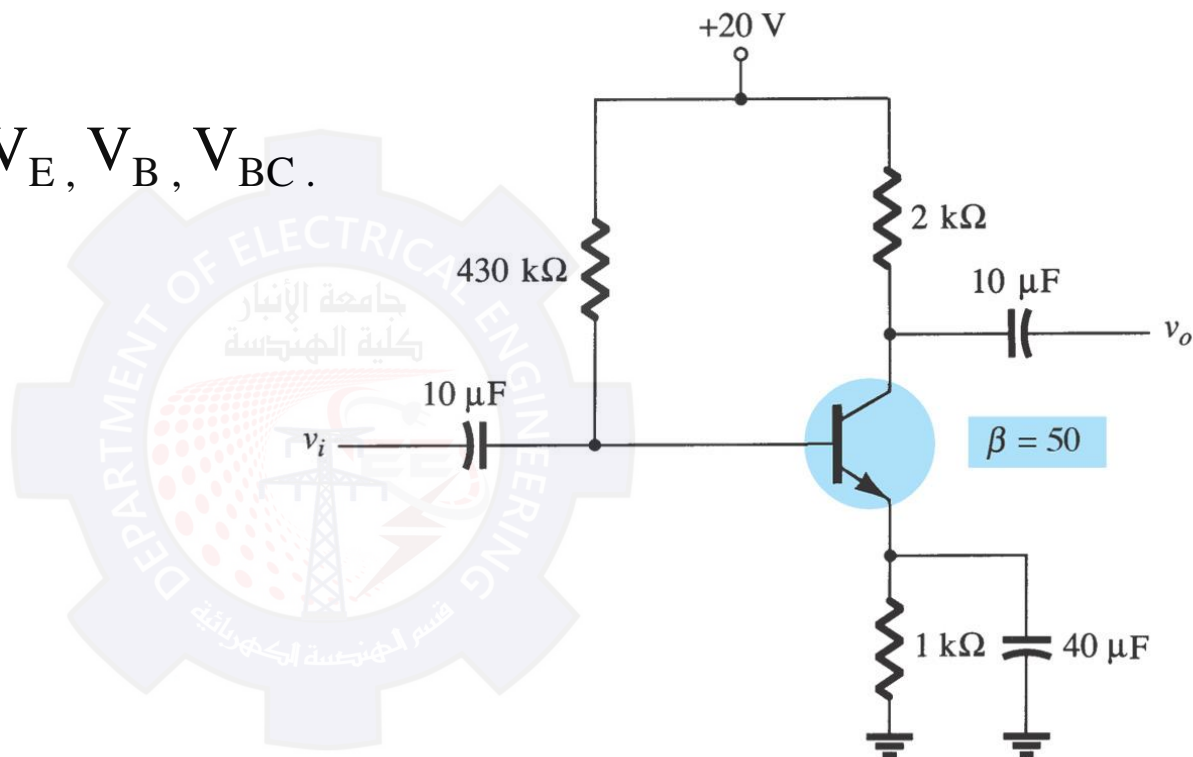
$$V_B = V_{CC} - I_B R_B = V_{BE} + V_E$$





Example 4.4

Find I_B , I_C , V_{CE} , V_C , V_E , V_B , V_{BC} .





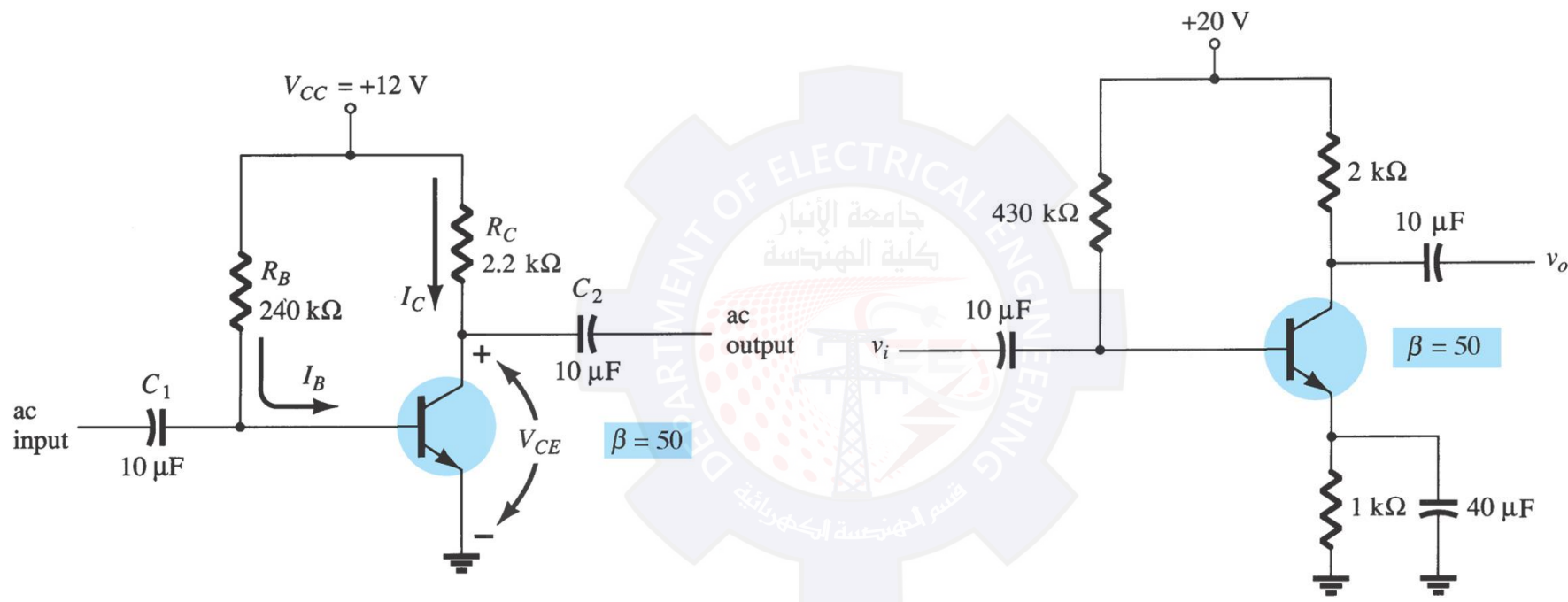
Improved Biased Stability

Stability refers to a circuit condition in which the currents and voltages will remain fairly constant over a wide range of temperatures and transistor Beta (β) values.

Adding R_E to the emitter improves the stability of a transistor.



Improved Biased Stability



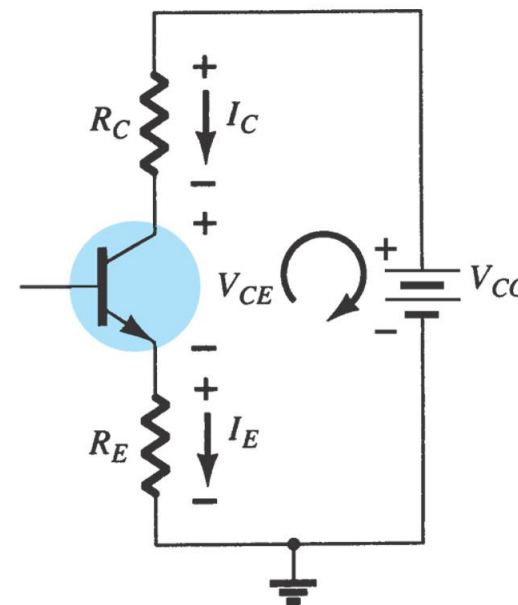
β	I_B (μA)	I_C (mA)	V_{CE} (V)
50	47.08	2.35	6.83
100	47.08	4.71	1.64

β	I_B (μA)	I_C (mA)	V_{CE} (V)
50	40.1	2.01	13.97
100	36.3	3.63	9.11



Load Line Analysis

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



$$V_{CE} = V_{CC} \Big|_{I_C = 0 \text{ mA}}$$

$$I_C = \frac{V_{CC}}{R_C + R_E} \Big|_{V_{CE} = 0 \text{ V}}$$

