COLLEGE OF ENGINEERING AND TECHNOLOGIES
ALMUSTAQBAL UNIVERSITY

Electronics

CTE 207

Lecture 17

- Voltage Feedback Bias -

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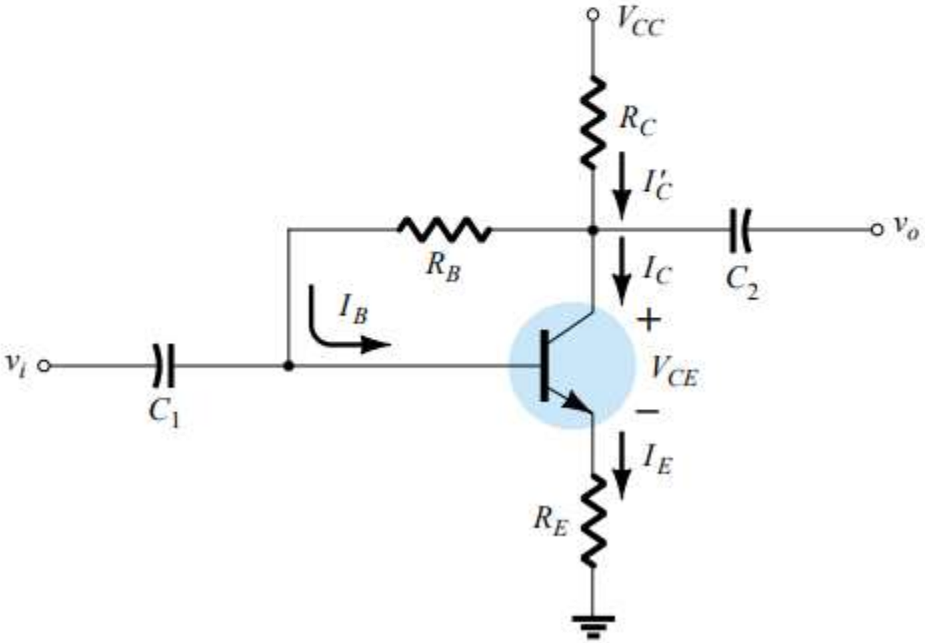
Voltage Feedback Bias

- An improved level of stability can also be obtained by introducing a feedback path from collector to base as shown in Figure below.

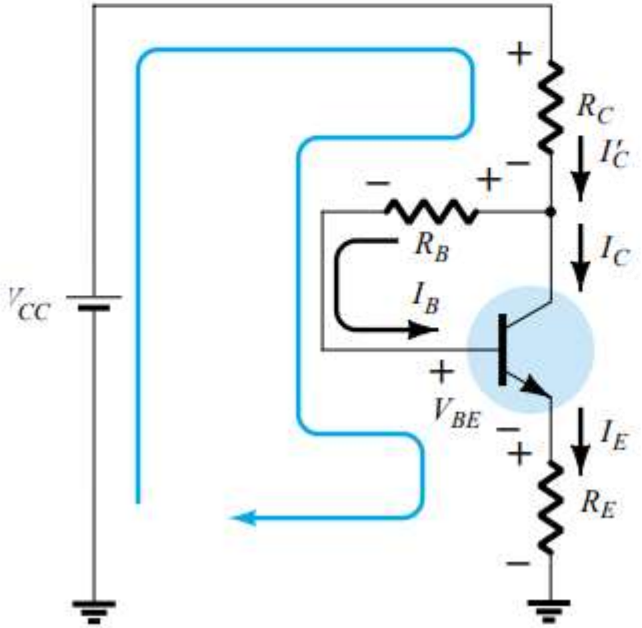
- Although the Q-point is not totally independent of beta (even under approximate conditions), the sensitivity to changes in beta or temperature variations is normally less than encountered for the fixed-bias or emitter-biased configurations.

- The analysis will again be performed by first analyzing the base – emitter loop with the results applied to the collector – emitter loop.

Voltage Feedback Bias



DC bias circuit with voltage feedback



Base – emitter loop for the network

Base – Emitter Loop

- The Figure above shows the base–emitter loop for the voltage feedback configuration.

- Writing Kirchhoff's voltage law around the indicated loop in the clockwise direction will result in

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

Base – Emitter Loop

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

Substituting $I'_C \cong I_C = \beta I_B$ and $I_E \cong I_C$

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

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

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

Collector – Emitter Loop

- The collector–emitter loop for the network of Figure below is provided.
- Applying Kirchhoff's voltage law around the indicated loop in the clockwise direction will result in

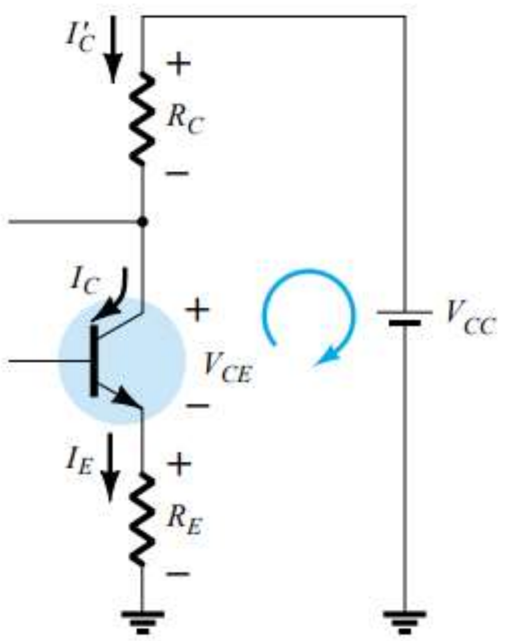
$$I_E R_E + V_{CE} + I'_C R_C - V_{CC} = 0$$

Since $I'_C \cong I_C$ and $I_E \cong I_C$, we have

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

and

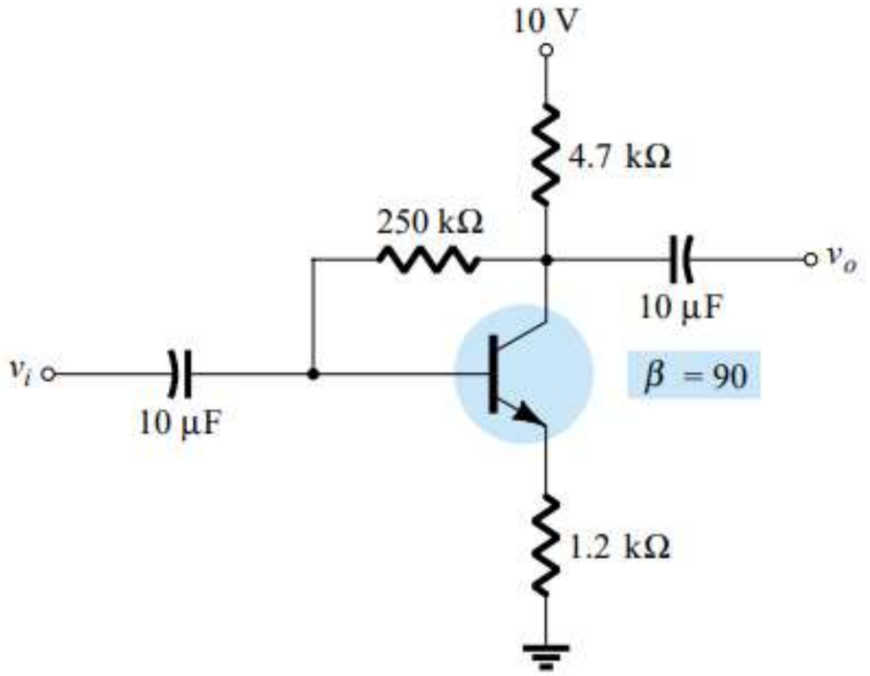
$$\boxed{V_{CE} = V_{CC} - I_C(R_C + R_E)}$$



Collector – emitter loop

Example 1

Determine the quiescent levels of IC and VCE for the network of the Figure below.



Network for Example 1

Solution

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

$$= \frac{10\text{ V} - 0.7\text{ V}}{250\text{ k}\Omega + (90)(4.7\text{ k}\Omega + 1.2\text{ k}\Omega)}$$

$$= \frac{9.3\text{ V}}{250\text{ k}\Omega + 531\text{ k}\Omega} = \frac{9.3\text{ V}}{781\text{ k}\Omega}$$

$$= 11.91\ \mu\text{A}$$

$$I_{C_Q} = \beta I_B = (90)(11.91\ \mu\text{A})$$

$$= \mathbf{1.07\ mA}$$

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

$$= 10\text{ V} - (1.07\text{ mA})(4.7\text{ k}\Omega + 1.2\text{ k}\Omega)$$

$$= 10\text{ V} - 6.31\text{ V}$$

$$= \mathbf{3.69\ V}$$

Example 2

Repeat Example 1 by using a beta of 135 (50% more than Example 1).

Sol:

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta(R_C + R_E)} = \frac{10\text{ V} - 0.7\text{ V}}{250\text{ k}\Omega + (135)(4.7\text{ k}\Omega + 1.2\text{ k}\Omega)}$$

$$= \frac{9.3\text{ V}}{250\text{ k}\Omega + 796.5\text{ k}\Omega} = \frac{9.3\text{ V}}{1046.5\text{ k}\Omega}$$

$$= 8.89\ \mu\text{A}$$

Solution

and $$I_{C_Q} = \beta I_B$$
$$= (135)(8.89\ \mu A)$$
$$= \mathbf{1.2\ mA}$$

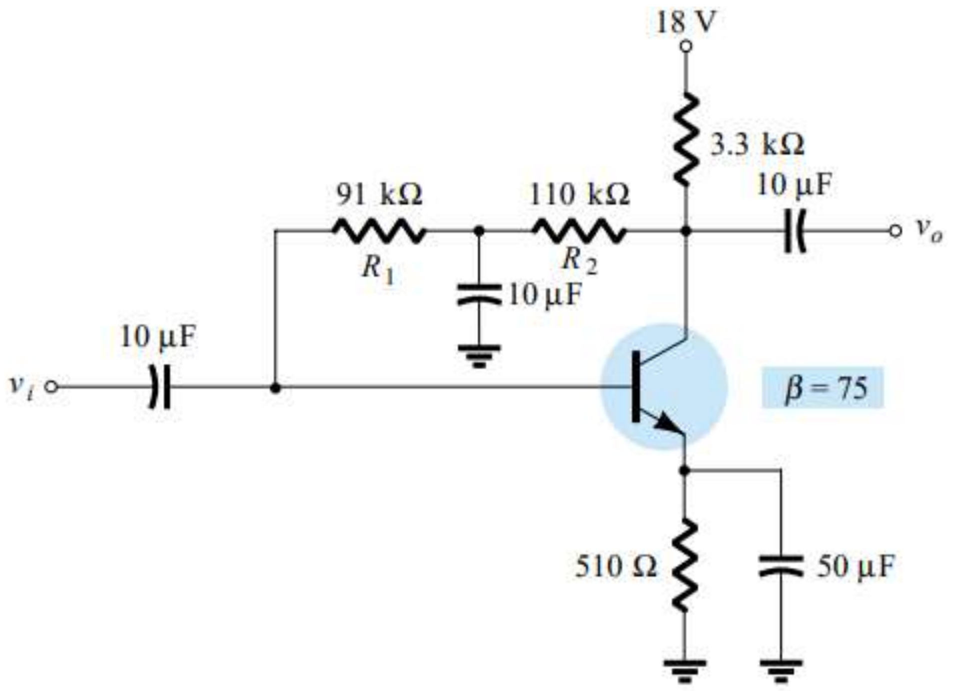
and $$V_{CE_Q} = V_{CC} - I_C(R_C + R_E)$$
$$= 10\ V - (1.2\ mA)(4.7\ k\Omega + 1.2\ k\Omega)$$
$$= 10\ V - 7.08\ V$$
$$= \mathbf{2.92\ V}$$

- Even though the level of beta increased 50%, the level of ICQ only increased 12.1% while the level of VCEQ decreased about 20.9%.

- If the network were a fixed-bias design, a 50% increase in would have resulted in a 50% increase in ICQ and a dramatic change in the location of the Q - poin.

Example 3

Determine the DC level of IB and VC for the network of the Figure below.



Network for Example 3

Solution

In this case, the base resistance for the DC analysis is composed of two resistors with a capacitor connected from their junction to ground.

For the dc mode, the capacitor assumes the open-circuit equivalence and $R_B = R_1 + R_2$.

Solving for I_B gives

Solution

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

$$= \frac{18\text{ V} - 0.7\text{ V}}{(91\text{ k}\Omega + 110\text{ k}\Omega) + (75)(3.3\text{ k}\Omega + 0.51\text{ k}\Omega)}$$

$$= \frac{17.3\text{ V}}{201\text{ k}\Omega + 285.75\text{ k}\Omega} = \frac{17.3\text{ V}}{486.75\text{ k}\Omega}$$

$$= \mathbf{35.5\ \mu A}$$

Solution

$$I_C = \beta I_B$$
$$= (75)(35.5\ \mu A)$$
$$= 2.66\ mA$$

$$V_C = V_{CC} - I'_C R_C \cong V_{CC} - I_C R_C$$
$$= 18\ V - (2.66\ mA)(3.3\ k\Omega)$$
$$= 18\ V - 8.78\ V$$
$$= \mathbf{9.22\ V}$$