University of Anbar
College of Engineering
Dept. of Electrical Engineering

Fundumantal of Electronic II

Second Class

Chapter05: BJT AC Analysis
Lec05_p4

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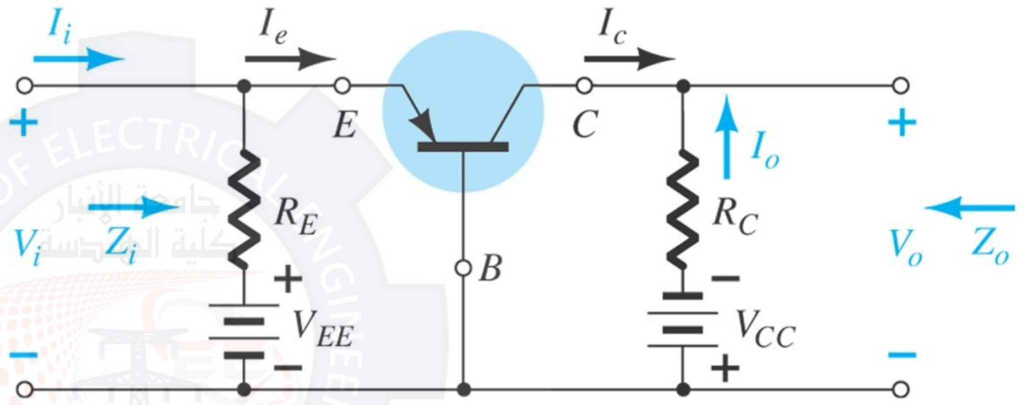
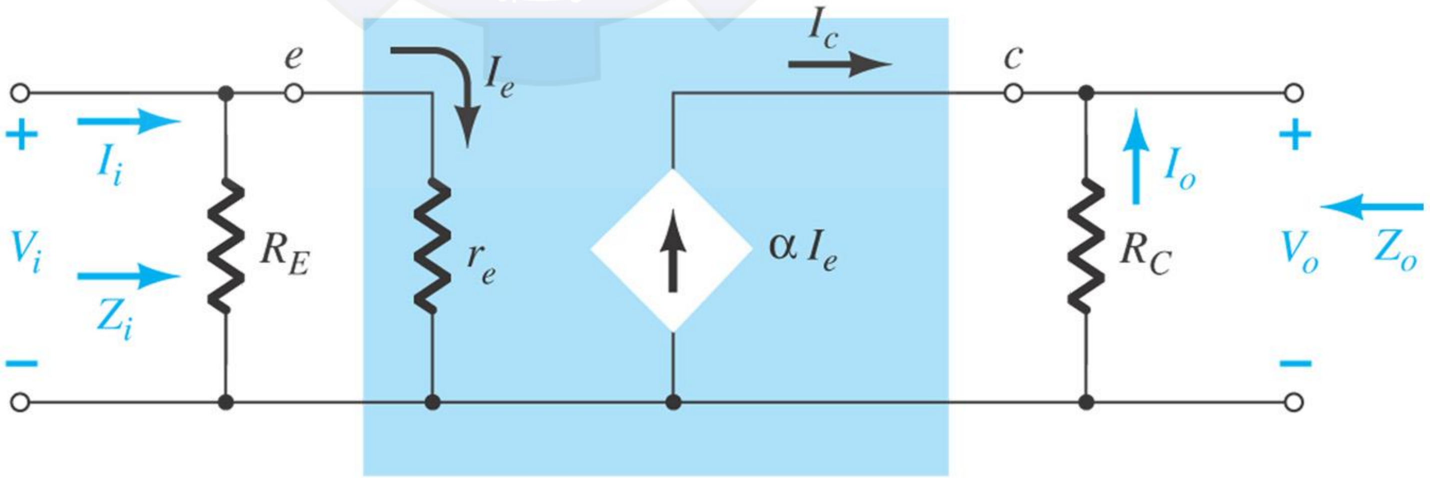
Common-Base Configuration

- The input is applied to the emitter.
- The output is taken from the collector.
- Low input impedance.
- High output impedance.
- Very high voltage gain.
- No phase shift between input and output.





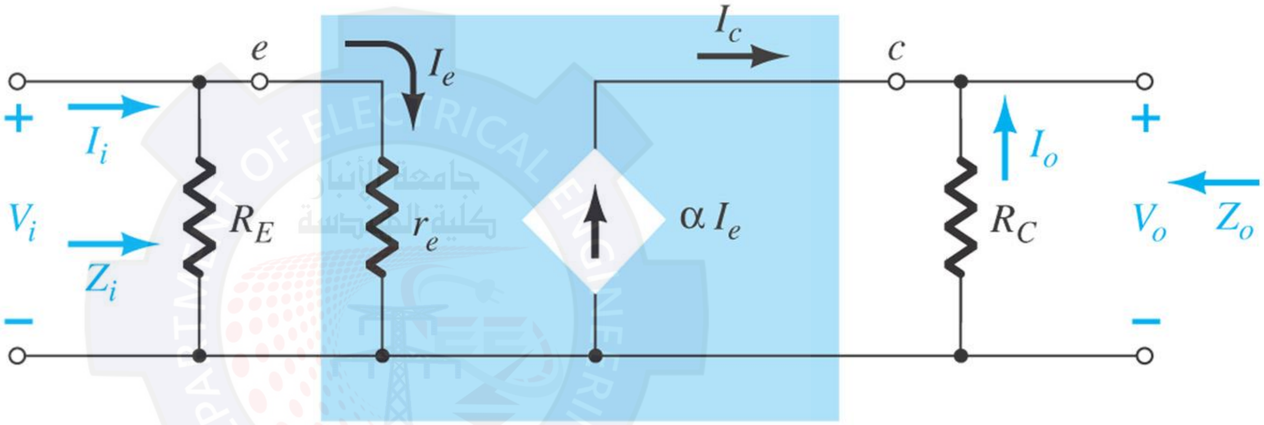
Calculations

Input impedance:

$$\mathbf{Z_i = R_E \,||\, r_e}$$

Output impedance:

$$\mathbf{Z_o = R_C}$$



Voltage gain:

$$\mathrm{V_o} = -I_o R_C = -(-I_C)R_C$$

$$= \alpha I_e R_C$$

$$I_e = \frac{V_i}{e} \rightarrow \mathrm{V_o} = \alpha\left(\frac{V_i}{r_e}\right)R_C$$

$$\mathrm{A_v} = \frac{\mathrm{V_o}}{\mathrm{V_i}} = \frac{\alpha \mathrm{R_C}}{\mathrm{r_e}} \cong \frac{\mathrm{R_C}}{\mathrm{r_e}}$$

$\mathrm{A_v}$ positive… $\mathrm{V_i}$ and $\mathrm{V_o}$ in phase.

Current gain:

Assuming $R_E >> r_e$

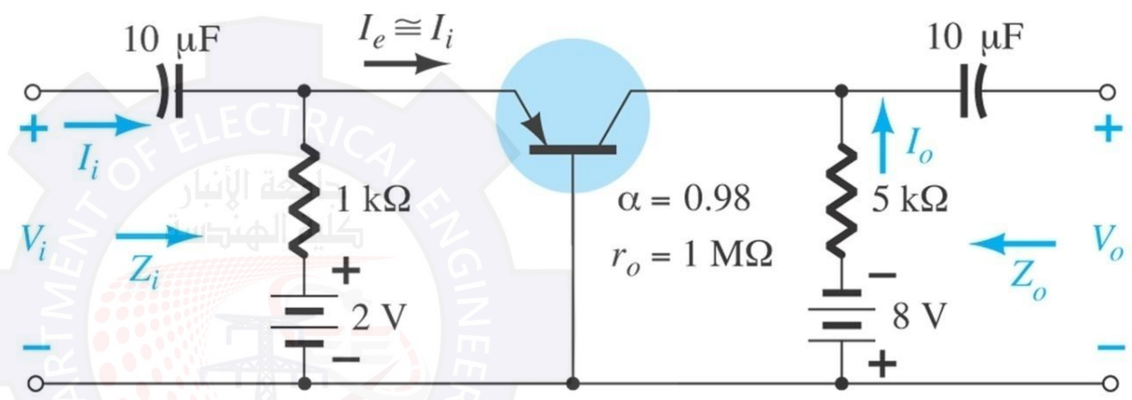
$$I_e = I_i$$

$$I_o = - \quad I_e = -\alpha I_i$$

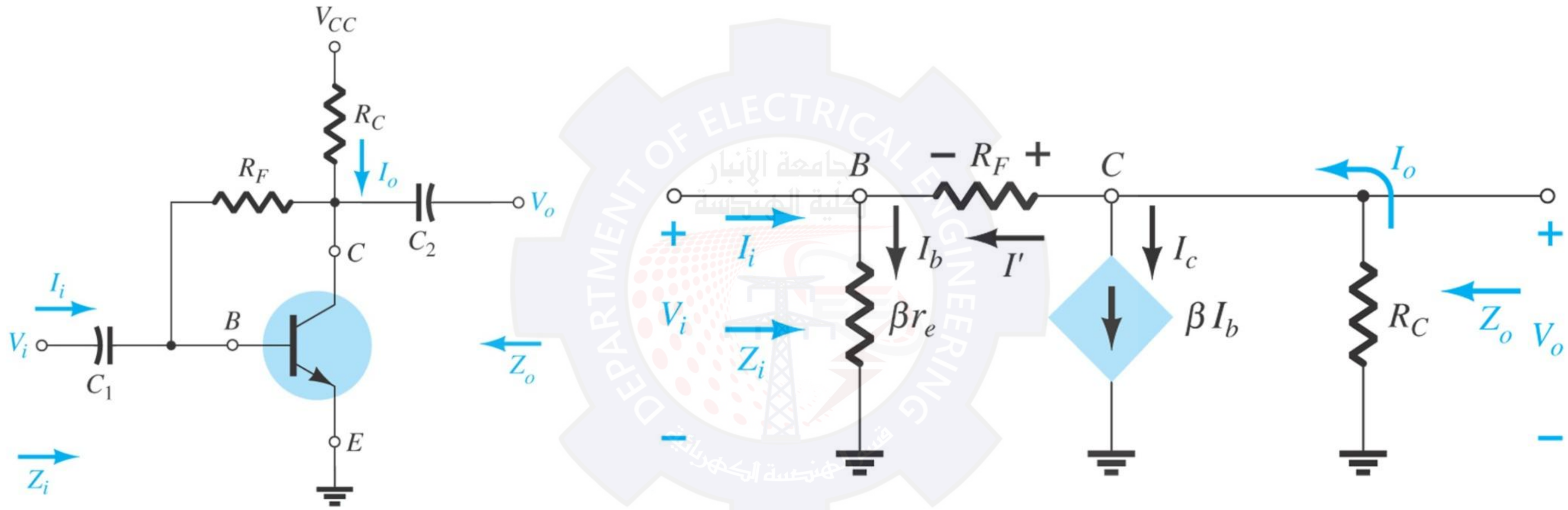
$$\mathrm{A_i} = \frac{\mathrm{I_o}}{\mathrm{I_i}} = -\alpha \cong -$$

Example 5.8

Determine r_e, Z_i , Z_o , A_v , A_i



Common-Emitter Collector Feedback Configuration



- This is a variation of the common-emitter fixed-bias configuration
- Input is applied to the base
- Output is taken from the collector
- There is a 180° phase shift between input and output

Calculations

Output impedance:

$$Z_o \cong R_C \| R_F$$

Voltage gain:

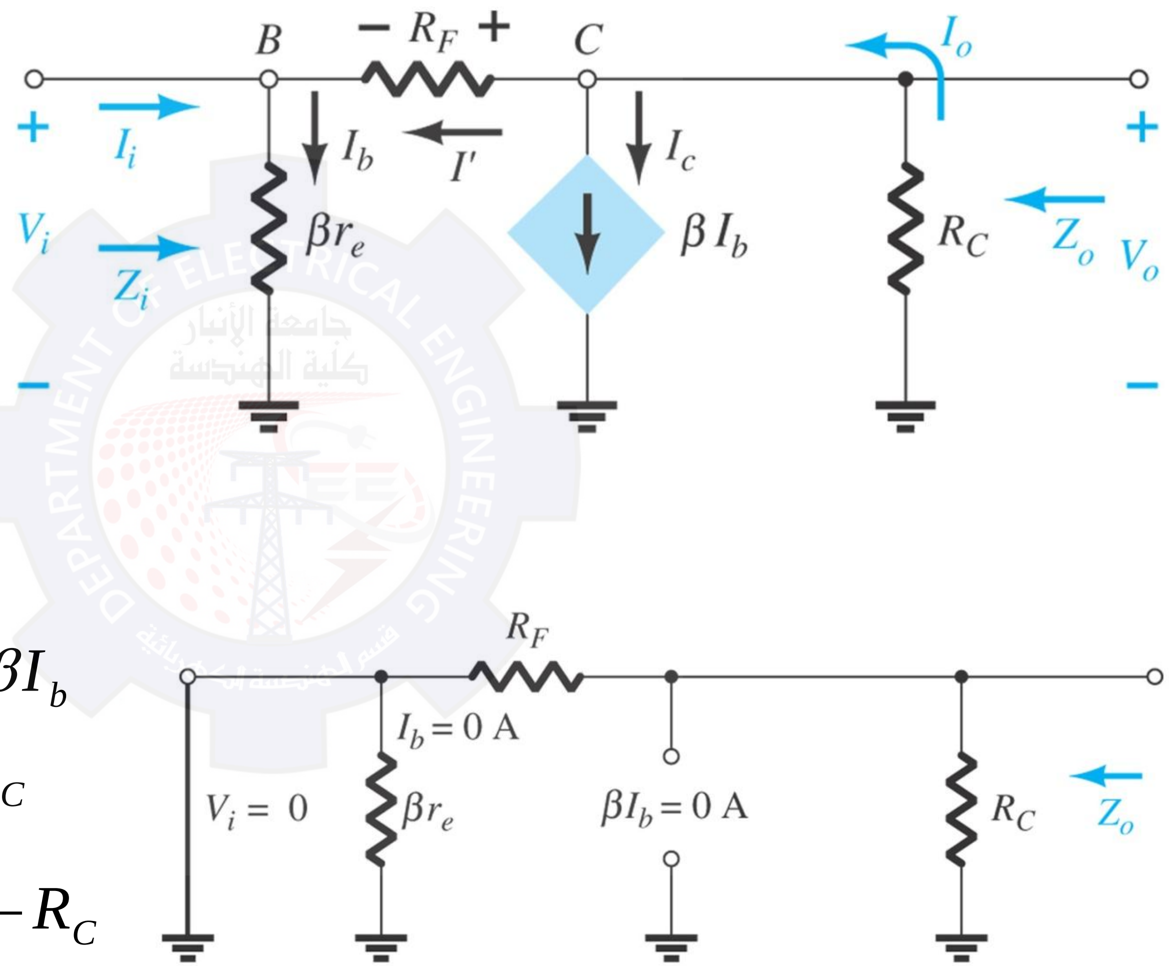
$$I_o = \beta I_b + I'$$

$$For\ \ \beta I_b >> I' \rightarrow I_o \cong \beta I_b$$

$$V_o = -I_o R_C = -(\beta I_b) R_C$$

$$I_b = \frac{V_i}{\beta r_e} \rightarrow V_o = -\beta \frac{V}{\beta r_e} R_C$$

$$A_v = \frac{V_o}{V_i} = -\frac{R}{r_e}$$



Defining Z_o

Calculations

Input impedance:

$$Z_i = \frac{V_i}{I_i}, \quad V_o = -\frac{V_i}{r_e} R_C$$

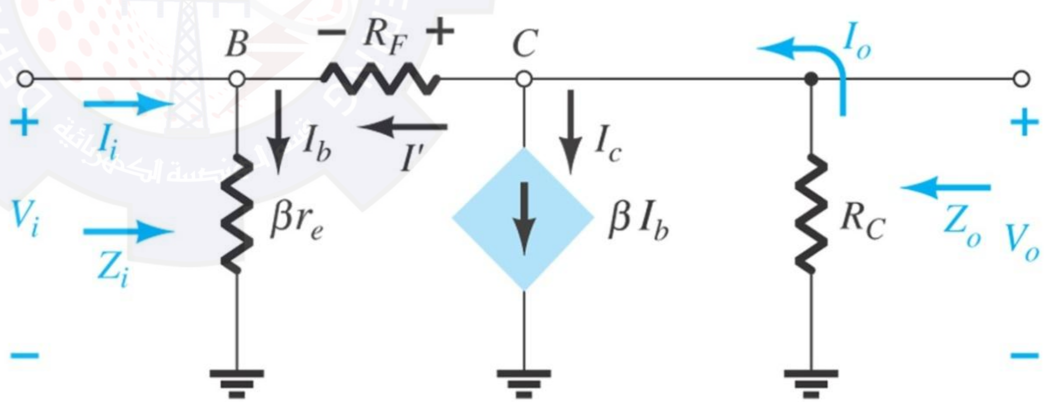
$$I' = \frac{V_o - V_i}{R_F} = \frac{V_o}{R_F} - \frac{V_i}{R_F} = -\frac{R_C V_i}{r_e R_F} - \frac{V_i}{R_F} = -\frac{1}{R_F}\left[1 + \frac{R_C}{r_e}\right] V_i$$

$$V_i = I_b \beta r_e = (I_i + I')\beta r_e = I_i \beta r_e + I' \beta r_e$$

$$V_i = I_i \beta r_e - \frac{1}{R_F}\left[1 + \frac{R_C}{r_e}\right] \beta r_e V_i$$

$$or \quad \mathrm{V_i}\left[1 + \frac{\beta r_e}{R_F}\left[1 + \frac{R_C}{r_e}\right]\right] = I_i \beta r_e$$

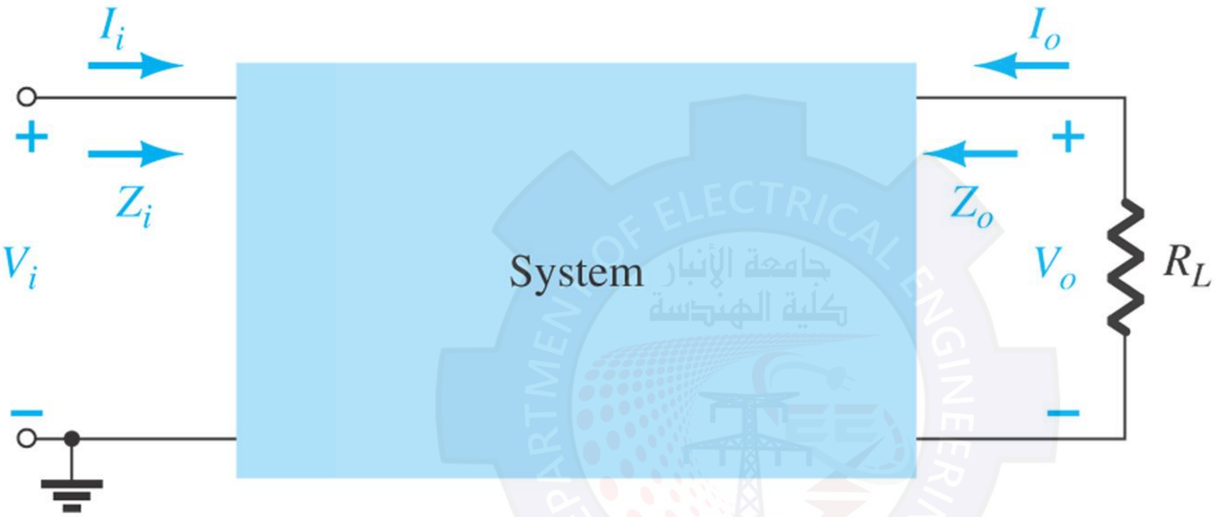
$$Z_i = \frac{V_i}{I_i} = \frac{\beta r_e}{1 + \frac{\beta r_e}{R_F}\left[1 + \frac{R_C}{r_e}\right]}$$



$$1 + \frac{R_C}{r_e} \cong \frac{R_C}{r_e} \rightarrow Z_i = \frac{\beta r_e}{1 + \frac{\beta R_C}{R_F}}$$

$$\mathbf{Z_i = \frac{r_e}{\frac{1}{\beta} + \frac{R_C}{R_F}}}$$

Determining the current gain using the voltage gain



Current Gain $A_i = \frac{I_o}{I_i}$, $I_i = \frac{V_i}{Z_i}$, $I_o = -\frac{V_o}{R_L}$

$$A_{i_L} = \frac{I_o}{I_i} = \frac{-\frac{V_o}{R_L}}{\frac{V_i}{Z_i}} = -\frac{V_o}{V_i} \cdot \frac{Z_i}{R_L}$$

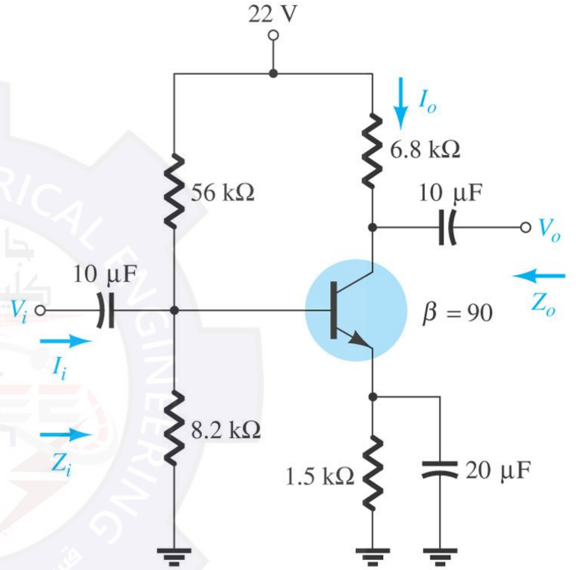
$$A_i = -A_{v_L} \frac{Z_i}{R_L}$$

Determining the current gain using the voltage gain

From example 5.2

Z_i=1.35 kΩ.

A_v=-368.76

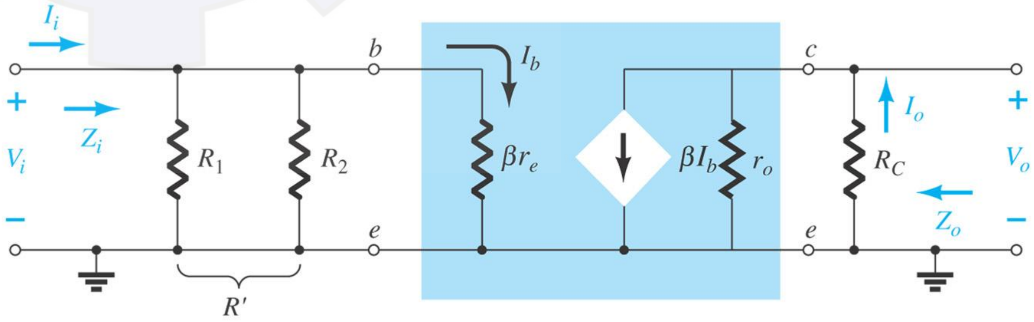


Current Gain $A_i = \frac{I_o}{I_i}$,

$$I_i = \frac{V_i}{1.35k} \quad , \quad I_o = -\frac{V_o}{6.8k}$$

$$A_{i_L} = \frac{I_o}{I_i} = \frac{-\frac{V_o}{6.8k}}{\frac{V_i}{1.35k}} = -\frac{V_o}{V_i} \cdot \frac{1.35k}{6.8k}$$

$$= -(-368.76)\frac{1.35k}{6.8k} = 73.2$$



or $A_i = -A_{v_L}\frac{Z_i}{R_L} = -(-368.76)\frac{1.35k}{6.8k} = 73.2$