University of Anbar
College of Engineering
Dept. of Electrical Engineering

Fundumantal of Electronic II

Second Class

Chapter05: BJT AC Analysis
Lec05_p2

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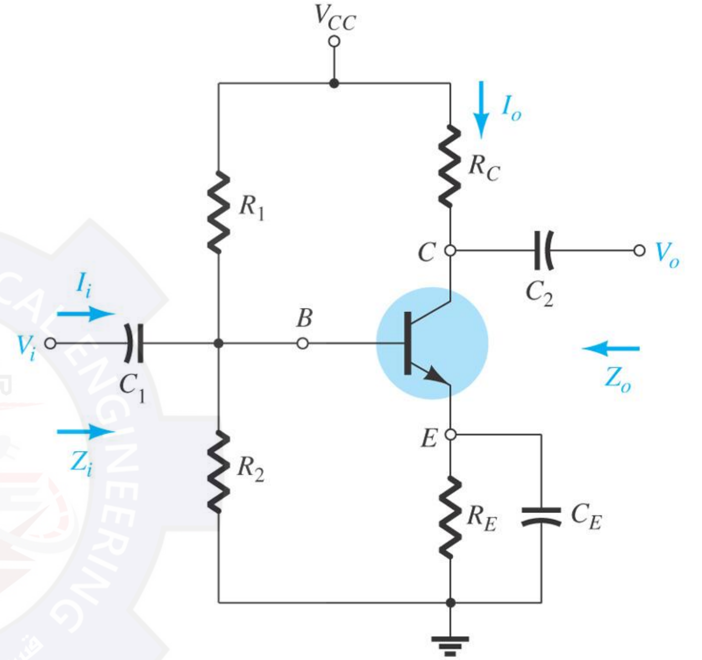
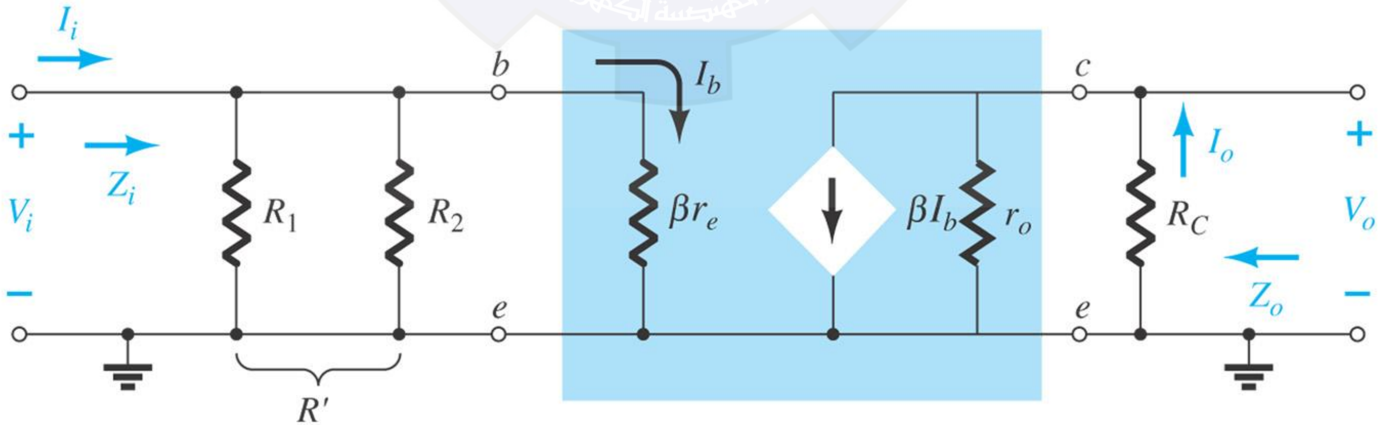
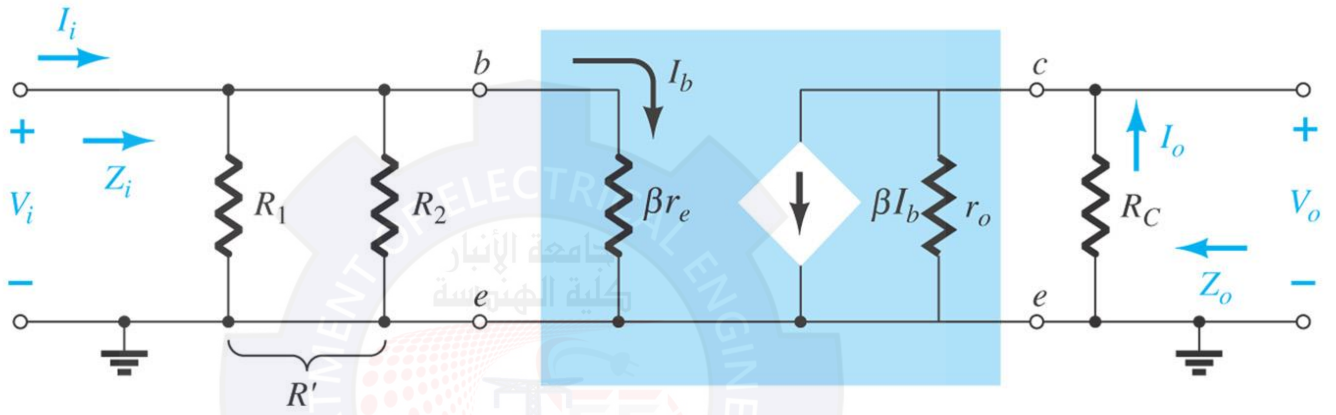
Common-Emitter Voltage-Divider Bias





r_e model requires you to determine β, r_e, and r_o.

Common-Emitter Voltage-Divider Bias



Input impedance:

$$R' = R_1 \,||\, R_2$$

$$Z_i = R' \,||\, \beta r_e$$

Output impedance:

$$Z_o = R_C \,||\, r_o$$

$$Z_o \cong R_C \Big|_{r_o \geq 10R_C}$$

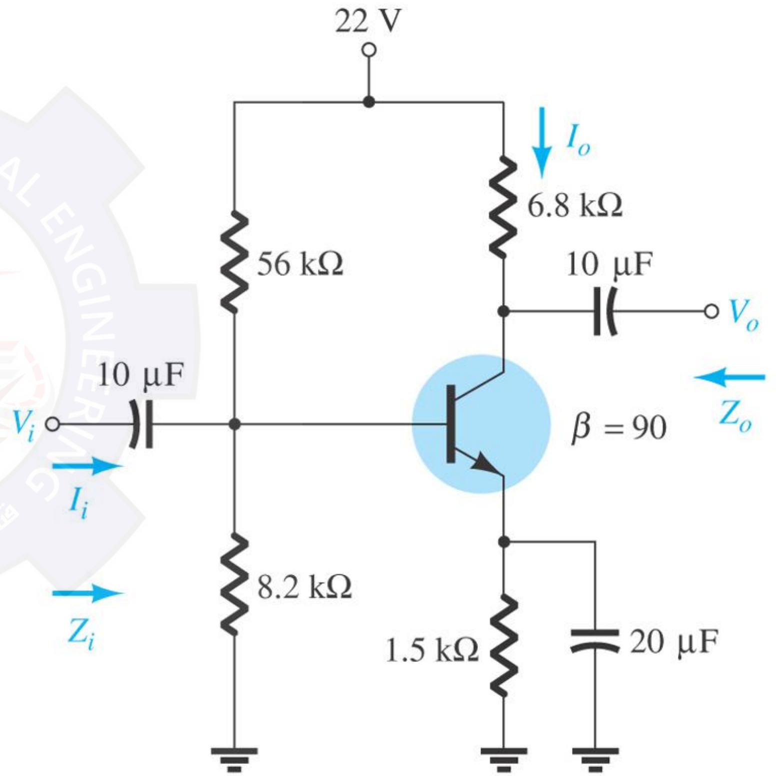
Voltage gain:

$$V_o = -\ I_b (R_C || r_o)\ ,\ I\ = \frac{V_i}{r_e}\ ,\ V_o = -\beta\left(\frac{V_i}{\beta r_e}\right)(R_C || r_o)$$

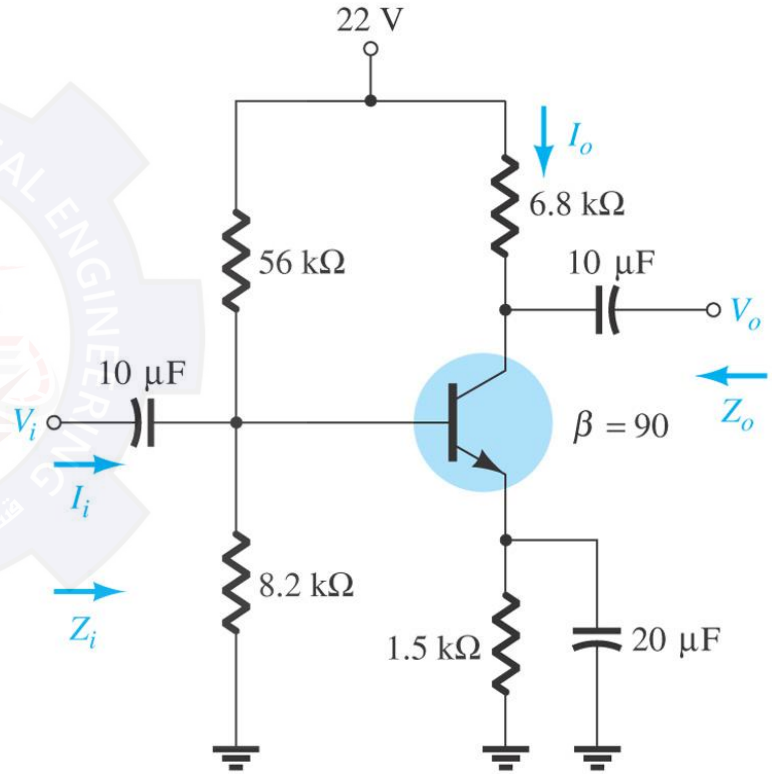
$$A_v = \frac{V_o}{V_i} = -\frac{(R_C || r_o)}{r_e}\quad ,\quad A_v = -\frac{R_C}{r_e}\Big|_{r_o \geq 10R}$$

Example 5.2

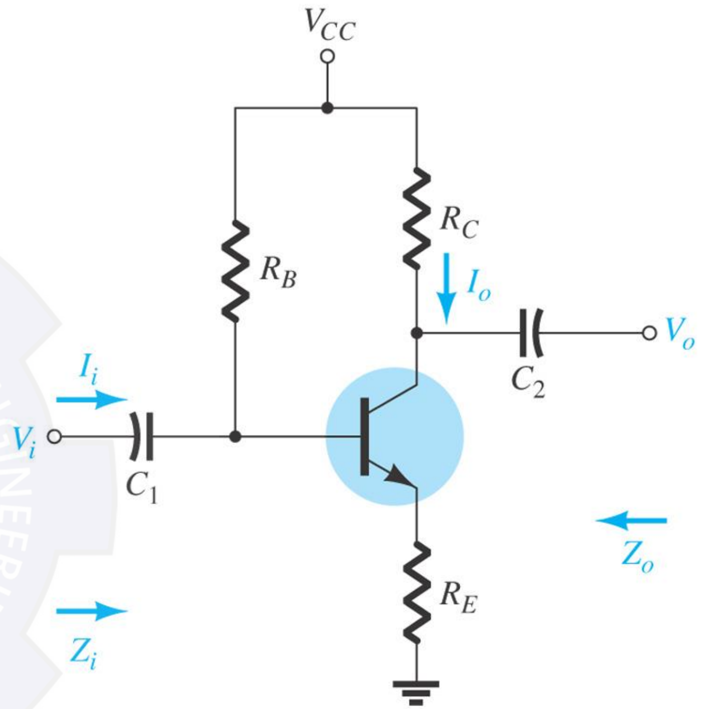
Determine r_e, Z_i , Z_o (with $r_o=\infty$), A_v (with $r_o=\infty$). Repeat with $r_o=50$ kΩ.

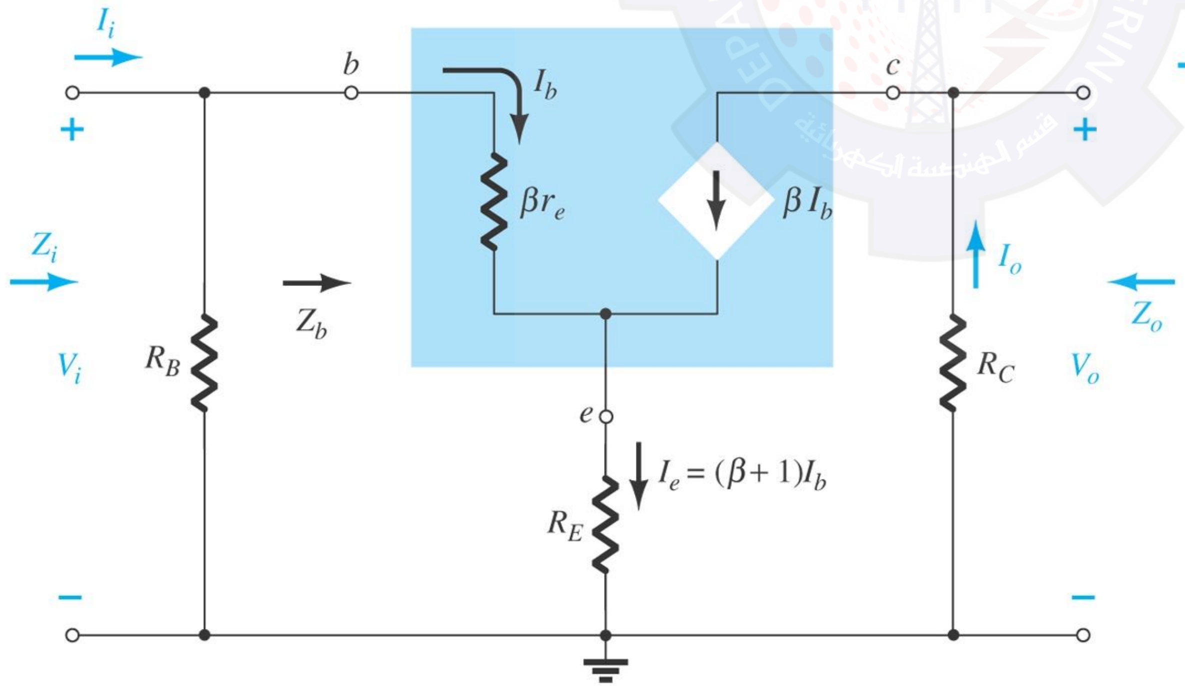


Example 5.2 - Solution

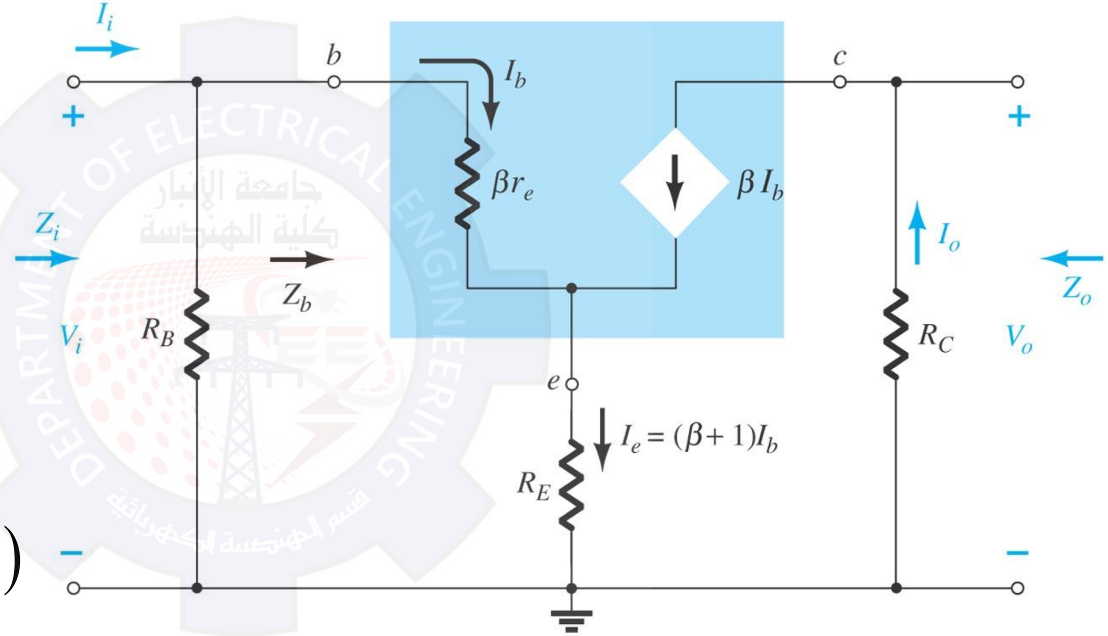


Common-Emitter
Emitter-Bias Configuration





Impedance Calculations



Input impedance:

$$V_i = I_b \beta r_e + I_e R_E$$

$$V_i = I_b \beta r_e + (\beta + 1) I_b R_E$$

$$Z_b = \frac{V_i}{I_b} = \beta r_e + (\beta + 1) R_E$$

$$Z_b \cong \beta r_e + \beta R_E = \beta (r_e + R_E)$$

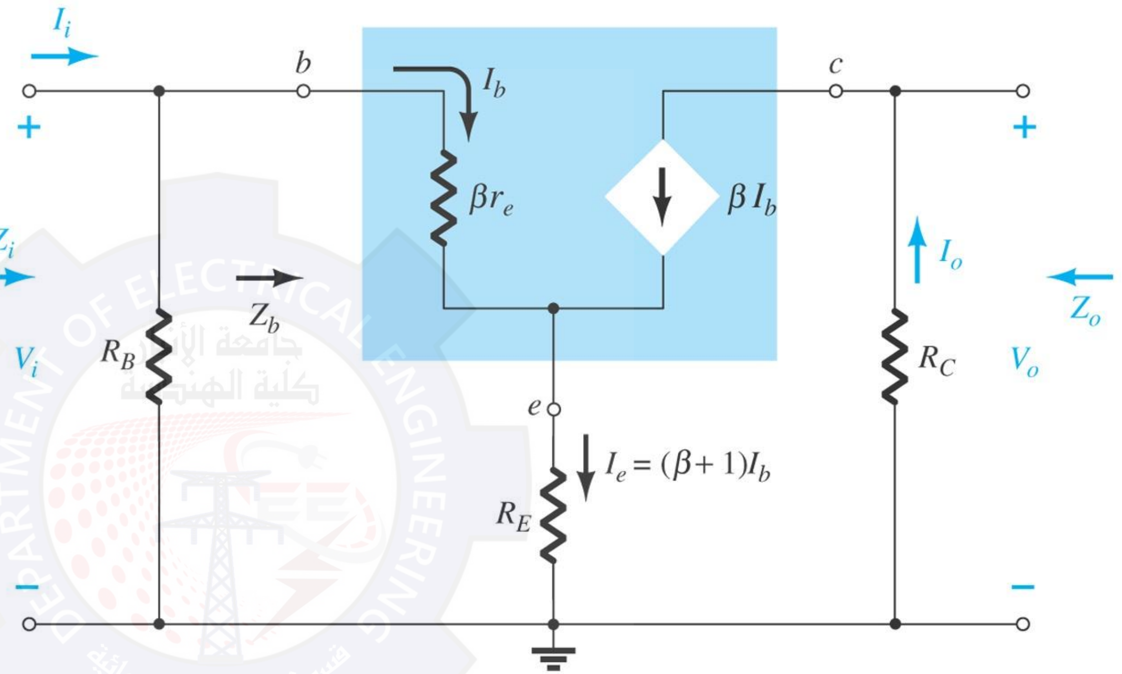
$$Z_b \cong \beta R_E \quad \text{for } R_E >> r_e$$

$$Z_i = R_B || Z_b$$

Output impedance:

$$Z_o = R$$

Gain Calculations



Voltage gain:

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

$$V_o = -\beta \left(\frac{V_i}{Z_b} \right) R_C$$

$$A_v = \frac{V_o}{V_i} = -\frac{\beta R_C}{Z_b}$$

substituting $Z_b \cong \beta(r_e + R_E)$

$$A_v = \frac{V_o}{V_i} = -\frac{R_C}{r_e + R_E}$$

and for the approximation $Z_b \cong \beta R$

$$A_v = \frac{V_o}{V_i} \cong -\frac{R}{R_E}$$

Example 5.3 Without C_E (unbypassed):

Determine r_e, Z_i , Z_o , A_v . ignore r_o for $r_o \geq 10(R_C+R_E)$