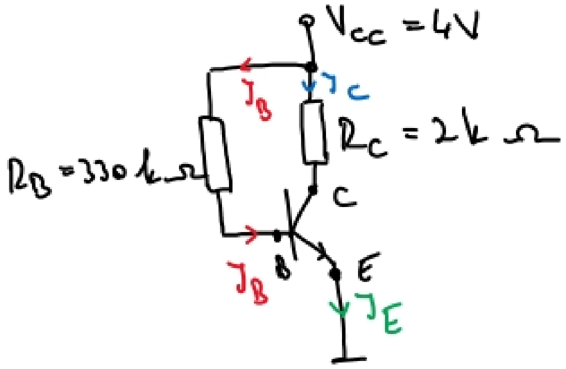
Seminar 4 electronică V 1

P1.



$I_C = ?$ $\quad U_{R_C} = ?$

$I_B = ?$ $\quad U_{R_B} = ?$

$I_E = ?$

$U_{CE} = ?$

$U_{BE} = ?$

$U_{CB} = ?$

$\beta = 100$

$U_{BE} \simeq 0.7V$

$$U_{R_B} = V_{CC} - U_{BE} = 4 - 0.7 = 3.3V$$

$$U_{R_B} = I_B \cdot R_B \Rightarrow I_B = \frac{U_{R_B}}{R_B} = \frac{3.3V}{330k\Omega} = \frac{3.3}{330\times10^3} A =$$

$$= \frac{3.3}{330} \times 10^{-3} A = 0.01 \times 10^{-3} A = 0.01\ mA = 10\mu A$$

$$I_C \simeq \beta I_B = 100 \times 10\mu A = 1mA$$

$$I_E = I_B + I_C = 0.01\ mA + 1mA = 1.01\ mA$$

$$\text{o.k. } I_E \simeq I_C = 1mA$$

$$U_{R_C} = I_C \cdot R_C = 1mA \cdot 2k\Omega = 10^{-3} A \cdot 2\times10^{3}\ \Omega = 2V$$

$$V_{CC} = U_{R_C} + U_{CE} \Leftrightarrow 4V = 2V + U_{CE} \Rightarrow U_{CE} = 2V$$

$$U_{CB} = U_{CE} - U_{BE} = 2V - 0.7V = 1.3V$$

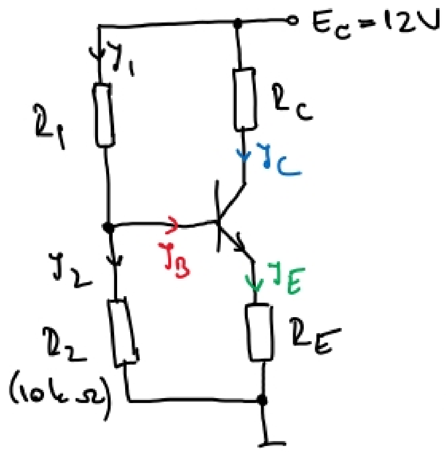
P10.

$R_1 = ?; R_C = ?; R_E = ?; I_B = ?$

$I_{C_0} = 2mA; \beta = 100; U_{CE_0} = 3V$

$U_{BE_0} = 0.65V$

$R_2 = 10\,k\Omega$



$I_C = \beta I_B \Rightarrow$

$\Rightarrow I_B = \frac{I_C}{\beta} = \frac{2\,mA}{100} = 0.02\,mA = 20\,\mu A$

$I_E = I_C + I_B = 2\,mA + 0.02\,mA = 2.02\,mA$

Din considerente practice:

$R_E \approx \frac{1}{10} \cdot \frac{E_C}{I_C} = \frac{1}{10} \cdot \frac{12V}{2mA} = \frac{1}{10} \cdot 6 \cdot 10^3 =$

$= 6 \times 10^2\,\Omega = 600\,\Omega$

$E_C = U_{R_C} + \underbrace{U_{CE}}_{3V} + U_{R_E} \Leftrightarrow 12V = I_C R_C + 3V + 2.02\,mA \times 600\,\Omega$

$12V = 2mA \times R_C + 3V + 1.212V$

$7.788V = 2mA \times R_C \Rightarrow R_C = \frac{7.788V}{2\,mA} = 3.894\,k\Omega$

$U_{R_2} = U_{BE} + U_{R_E} = 0.65V + 1.212V = 1.862V$

$U_{R_2} = I_2 \times R_2 \Rightarrow I_2 = \frac{U_{R_2}}{R_2} = \frac{1.862V}{10\,k\Omega} = 0.1862 \times 10^{-3}\,A$

$I_2 = 186.2\,\mu A$

$I_1 = I_2 + I_B = 186.2\,\mu A + 20\,\mu A = 206.2\,\mu A$

$U_{R_1} = 12 - U_{R_2} = 12V - 1.862V = 10.138V$

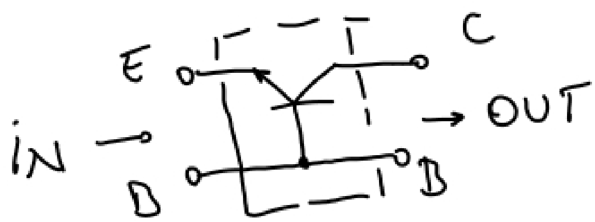
$U_{R_1} = R_1 \times I_1 \Rightarrow R_1 = \frac{U_{R_1}}{I_1} = \frac{10.138V}{206.2\,\mu A} = 49.166\,k\Omega$

Amplificatoare cu TB:

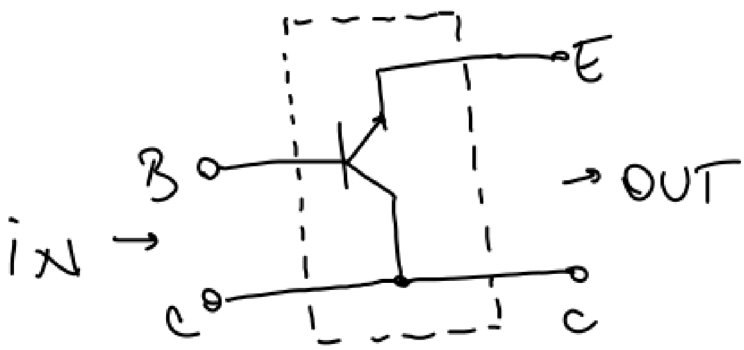
PSF → regim static (DC) $\quad I_C = \beta I_B \Rightarrow U_{CE}, U_{BE} \dots$

→ Conexiuni ale TB:

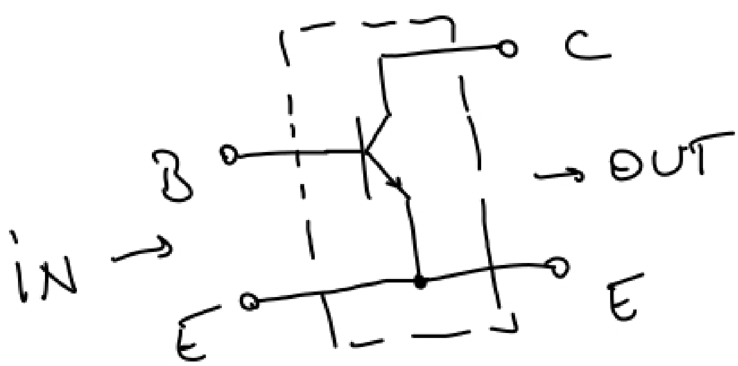
•) Bază comună („voltage gain")



•) Colector comun („current gain")



•) Emitor comun („current + voltage gain")



Parametrii amplificatoarelor:

- factorul de amplificare

$$A_u = \frac{V_{out}}{V_{in}} \quad \text{(câștig în tensiune)}$$

$$A_i = \frac{I_{out}}{I_{in}} \quad \text{(câștig în curent)}$$

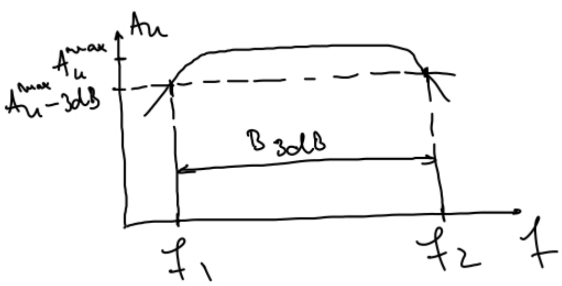
$$A_p = \frac{P_{out}}{P_{in}} \quad \text{(câștig în putere)}$$

$$A_u\,(dB) = 20 \log_{10} \frac{V_{out}}{V_{in}}$$

$$A_i\,(dB) = 20 \log_{10} \frac{I_{out}}{I_{in}}$$

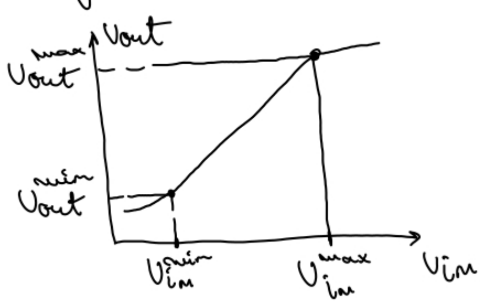
$$A_p\,(dB) = 10 \log_{10} \frac{P_{out}}{P_{in}}$$

- banda de trecere (B_{3dB}) („bandwidth")



$$B_{3dB} = f_2 - f_1 \quad (Hz)$$

- gama dinamică („dynamic range")



$$D = 20 \log_{10} \frac{V_{out}^{max}}{V_{out}^{min}} = 20 \log \frac{V_{in}^{max}}{V_{in}^{min}}$$

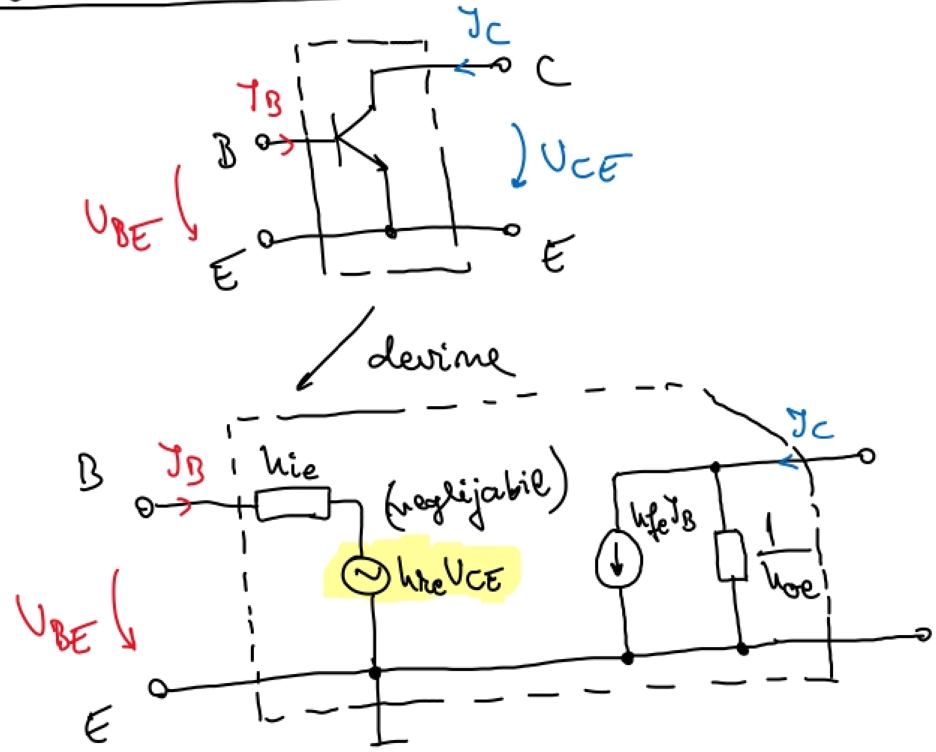
- impedanța de intrare

$$Z_{in} = \frac{V_{in}}{I_{in}} \quad (\Omega)$$

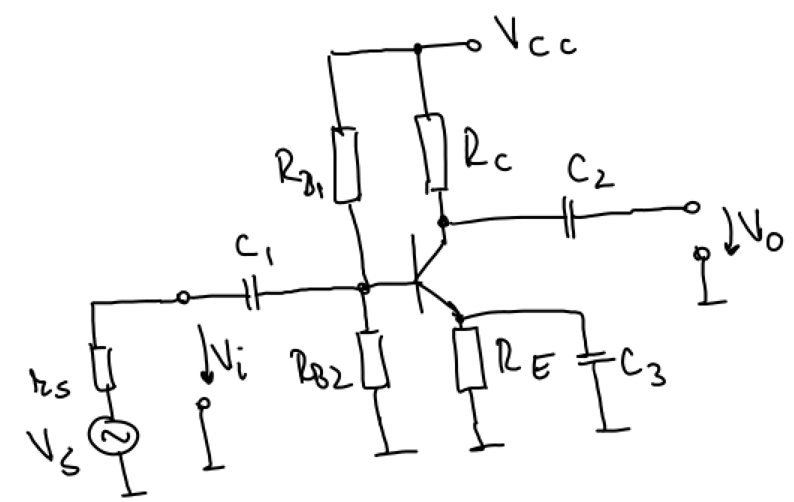
- impedanța de ieșire

$$Z_{out} = \frac{V_{out}^{gol}}{I_{out}^{sc}}$$

Modelul hibrid al conexiunii emitor comun:

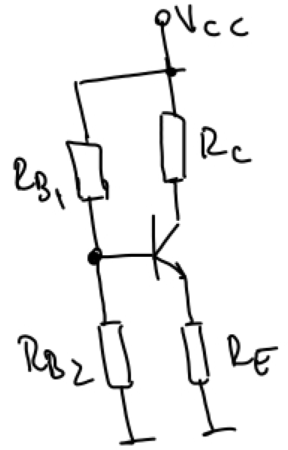


Amplificatorul cu TB conexiune emitor comun:



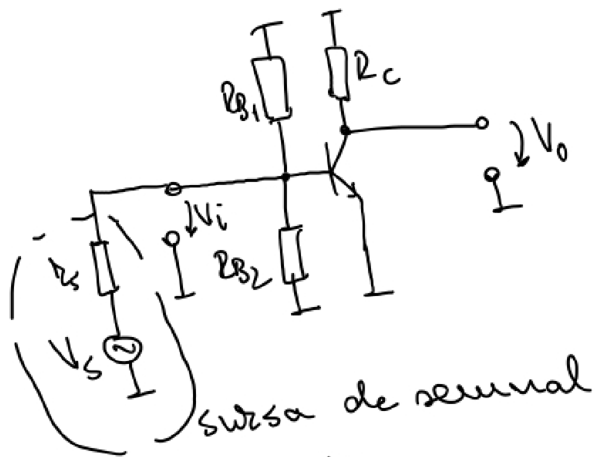
Vrem să aflăm Z_{in}, Z_{out} A_u, A_i

Schema echivalentă DC:



→ determinăm coordonatele PSF

Schema echivalentă AC:



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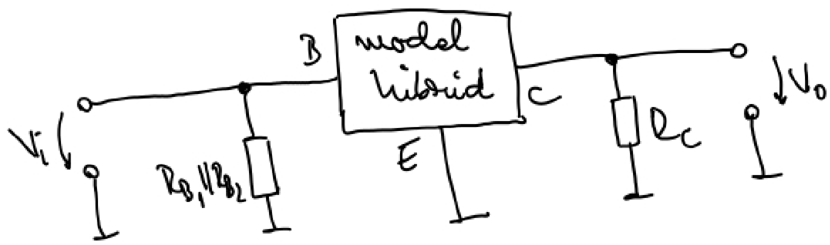

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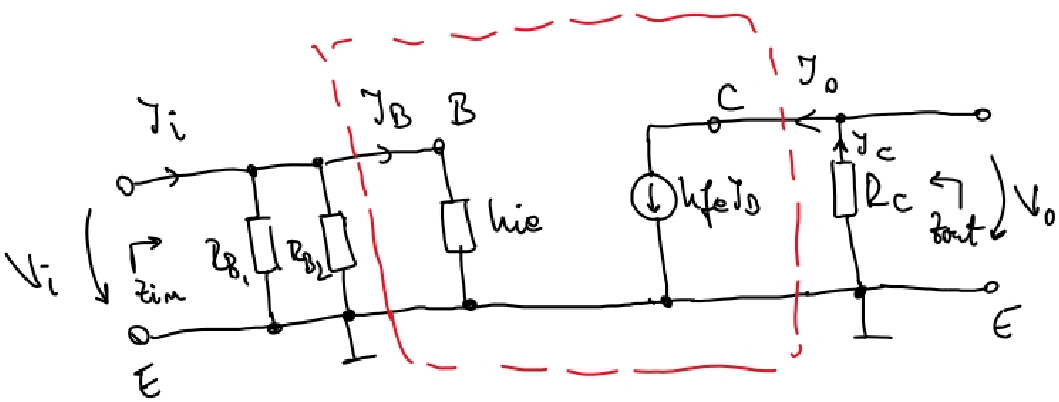

$$Z_{in} = R_{B_1} \| R_{B_2} \| h_{ie}$$

$$\frac{1}{Z_{in}} = \frac{1}{R_{B_1}} + \frac{1}{R_{B_2}} + \frac{1}{h_{ie}} = \frac{R_{B_2} h_{ie} + R_{B_1} h_{ie} + R_{B_1} R_{B_2}}{R_{B_1} R_{B_2} h_{ie}} \Rightarrow$$

$$Z_{in} = \frac{R_{B_1} R_{B_2} h_{ie}}{R_{B_1} R_{B_2} + h_{ie}(R_{B_1} + R_{B_2})}$$

$$Z_{out} = R_C$$

$$V_0 = -I_C \cdot R_C = -h_{fe} \cdot I_B \cdot R_C$$

$$V_i = I_B \cdot h_{ie}$$

$$A_u = \frac{V_0}{V_i} = -\frac{h_{fe} \cdot \cancel{I_B} \cdot R_C}{\cancel{I_B} \cdot h_{ie}} = -\frac{h_{fe}}{h_{ie}} \cdot R_C$$

$$A_i = \frac{I_0}{I_i} = \frac{I_C}{I_i} = \frac{h_{fe} I_B}{I_i}$$

$$I_i = \frac{V_i}{Z_{in}} = \frac{I_B \cdot h_{ie}}{Z_{in}}$$

$$\Rightarrow A_i = \frac{h_{fe} \cdot \cancel{I_B}}{\frac{\cancel{I_B} \cdot h_{ie}}{Z_{in}}} = \frac{h_{fe}}{h_{ie}} \cdot Z_{in}$$

$$A_i = \frac{h_{fe}}{h_{ie}} \cdot \frac{R_{B1} R_{B2} h_{ie}}{R_{B1} R_{B2} + h_{ie}(R_{B1} + R_{B2})} =$$

$$= \frac{h_{fe}}{\cancel{h_{ie}}} \cdot \cancel{h_{ie}} \cdot \frac{R_{B1} R_{B2}}{R_{B1} R_{B2} + h_{ie}(R_{B1} + R_{B2})} \simeq 1$$

$$A_i \simeq h_{fe}$$