

E-30) a)

L'ikströms schema:

$$E = 24 \text{ V}$$

$$R_2 = 10 \text{ k}\Omega$$

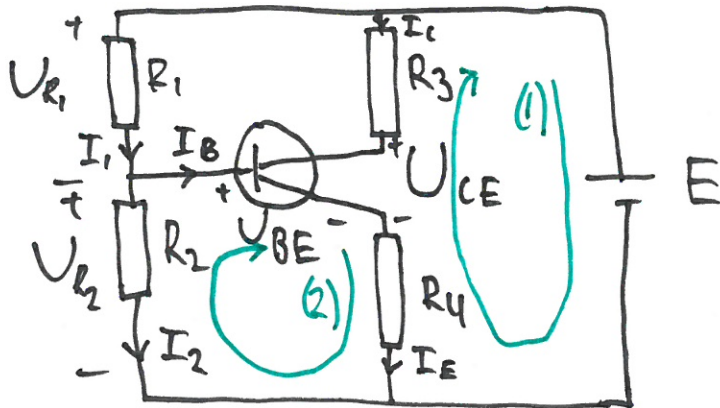
$$R_4 = 2.0 \text{ k}\Omega$$

$$U_{CE} = 6.0 \text{ V}$$

$$I_C = 3.0 \text{ mA}$$

$$U_{BE} = 0.60 \text{ V}$$

$$h_{FE} = 50$$



$$(1) -E + R_4 \cdot I_E + U_{CE} + R_3 \cdot I_C = 0$$

$$I_E = I_C + I_B = I_C + \frac{I_C}{h_{FE}} \quad (1) \Rightarrow$$

$$-E + R_4 \cdot \left( I_C + \frac{I_C}{h_{FE}} \right) + U_{CE} + R_3 \cdot I_C = 0 \Rightarrow$$

$$R_3 = \frac{E - R_4 \cdot \left( I_C + \frac{I_C}{h_{FE}} \right) - U_{CE}}{I_C} \approx 4 \text{ k}\Omega$$

$$\boxed{R_3 \approx 4 \text{ k}\Omega}$$

$$(2) U_{R_2} - U_{BE} - I_E \cdot R_4 = 0 \Rightarrow$$

$$U_{R_2} = U_{BE} + R_4 \cdot \left( \frac{I_C}{h_{FE}} + I_C \right) \approx 6.72 \text{ V}$$

$$U_{R_1} = E - U_{R_2} \approx 17.28 \text{ V}$$

$$I_1 = I_B + I_2 = \frac{I_C}{h_{FE}} + \frac{U_{R_2}}{R_2} \approx 732 \text{ }\mu\text{A}$$

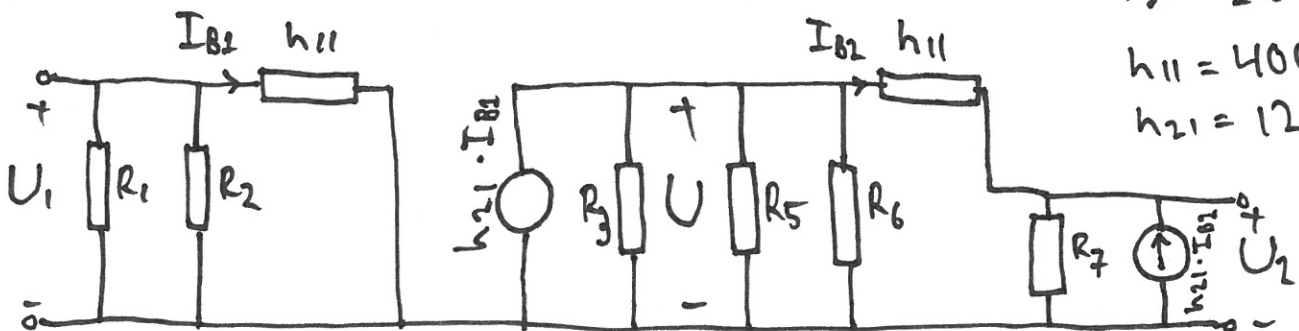
$$R_1 = \frac{U_{R_1}}{I_1} \approx 23.6 \text{ k}\Omega$$

$$\boxed{R_1 \approx 23.6 \text{ k}\Omega}$$

b) Bestimmung av  $F$

Småsignalschema:

$$\begin{aligned} R_1 &\approx 23.6 \text{ k}\Omega \\ R_2 = R_6 &= 10 \text{ k}\Omega \\ R_3 &= 4 \text{ k}\Omega \\ R_5 &= 20 \text{ k}\Omega \\ R_7 &= 2.0 \text{ k}\Omega \\ h_{11} &= 400 \Omega \\ h_{21} &= 125 \end{aligned}$$



$$F = \frac{U_2}{U_1} = \frac{U_2}{U} \cdot \frac{U}{U_1}$$

$$U_2 = R_7 \cdot (1 + h_{21}) \cdot I_{B2} = 252000 \cdot I_{B2}$$

$$U = h_{11} \cdot I_{B2} + R_7 \cdot (1 + h_{21}) \cdot I_{B2} = 252400 \cdot I_{B2}$$

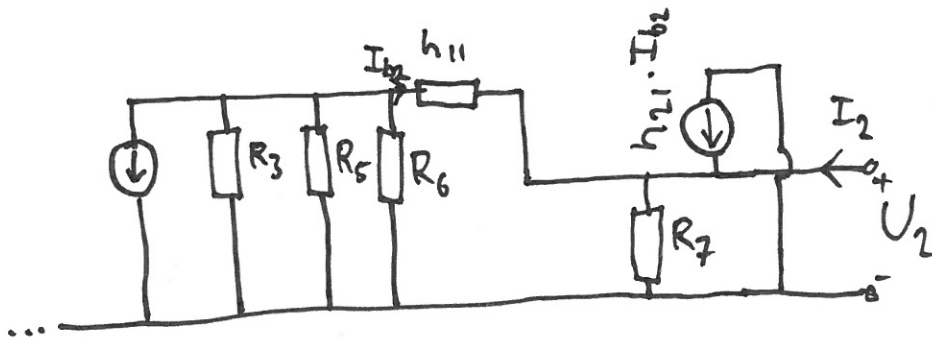
$$\begin{aligned} U &= -h_{21} \cdot I_{B1} \cdot R_3 \parallel R_5 \parallel R_6 \parallel \frac{U}{I_{B2}} = \\ &= -h_{21} \cdot I_{B1} \cdot R_3 \parallel R_5 \parallel R_6 \parallel (h_{11} + R_7 \cdot (1 + h_{21})) = \\ &= -309440 \cdot I_{B1} \end{aligned}$$

$$U_1 = h_{11} \cdot I_{B1} = 400 \cdot I_{B1}$$

$$F = \frac{U_2}{U_1} = \frac{U_2}{U} \cdot \frac{U}{U_1} = \frac{252000}{252400} \cdot \frac{-309440}{400} \approx -772$$

$$F \approx -772$$

Bestimmung av  $Z_{ut}$   
 småsignalschema:



$$Z_{ut} = \frac{U_2}{I_2}$$

$$(1) \quad U_2 = R_7 \cdot (I_2 + (1+h_{21}) \cdot I_{b2})$$

$$(2) \quad U_2 = -I_{b2} \cdot (h_{11} + R_3 \parallel R_5 \parallel R_6)$$

$$(2) \Rightarrow I_{b2} = \frac{-U_2}{h_{11} + R_3 \parallel R_5 \parallel R_6}$$

insatt i (1)  $\Rightarrow$

$$U_2 = R_7 \cdot I_2 - U_2 \cdot (1+h_{21}) \cdot R_7 / (h_{11} + R_3 \parallel R_5 \parallel R_6)$$

$$\Rightarrow R_7 \cdot I_2 = U_2 \cdot \left( 1 + \frac{(1+h_{21}) \cdot R_7}{h_{11} + R_3 \parallel R_5 \parallel R_6} \right)$$

$$\Rightarrow Z_{ut} = \frac{U_2}{I_2} = \frac{R_7}{1 + \frac{(1+h_{21}) \cdot R_7}{h_{11} + R_3 \parallel R_5 \parallel R_6}} \approx 23 \Omega$$

$Z_{ut} \approx 23 \Omega$